Postpartum Depression

A Risk factor for Infant Development and Infant-Mother Attachment?

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A Risk Factor for Infant Development and Infant-Mother Attachment?

PhD Thesis

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Contents

Preface

This PhD thesis was carried out at the University of Copenhagen's BabyLab, which was founded by Professor Simo Køppe and Associate Professors Susanne Harder and Mette Skovgaard Væver. It was supported by a research grant from the Carlsberg Foundation and the Department of Psychology. The study described here was part of an ongoing research project studying early interactional processes and later child development. The clinical part of the project was carried out in close collaboration with the staff at the University Clinic, Department of Psychology. The study complied with current Danish ethical standards in the assessment and treatment of the enrolled sample, and it was approved by Research Ethics Committee, Department of Psychology, University of Copenhagen.

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This thesis is dedicated to my father, Robert Smith.

Johanne Smith-Nielsen,
Copenhagen, October 2014

List of papers

PhD Paper 1

Johanne Smith-Nielsen, Howard Steele, Heike Mehlhase, Katharina Cordes, Miriam Steele, Susanne Harder, Mette S. Væver (2014). 'Links Among High EPDS Scores, State of Mind Regarding Attachment, and Symptoms of Personality Disorder', *Journal of Personality Disorders*, 28, 173.

PhD Paper 2

Johanne Smith-Nielsen, Mette Skovgaard Væver, Anne Tharner, Marianne Thode Krogh. 'Effects of Maternal Postpartum Depression in a Well-Resourced Sample: Early Concurrent and Longitudinal Effects on Infant Cognitive, Language, and Motor Development' (under review)

PhD Paper 3

Johanne Smith-Nielsen, Mette S. Væver, Anne Tharner, Howard Steele, Katharina Cordes, Heike Mehlhase. 'Postpartum Depression and Infant-Mother Attachment at One Year: The Impact of Co-Morbid Maternal Personality Disorder' (under review)

The papers appear in full length in Appendices II-IV.

Introduction

Becoming a mother is a major and life-changing event. It is difficult to point to other times in life where a woman's mental well-being and capacities for adaptation may have such far-reaching implications for her own, her family's, and her child's psychological health. This transition into parenthood rarely goes completely smooth and without sometimes feeling overwhelmed, unsure about how to handle the infant, enormously tired, or sad about having lost the exclusive one-to-one relationship with the partner and the independent life before the baby came. However, for some new mothers such feelings are debilitating and sustained. In fact, research has found that up to 19% of new mothers may experience symptoms of depression during the first three months after delivery (Gavin et al., 2005).

The overall objective of this PhD-project was to study maternal postpartum depression (PPD) as a risk factor for the emergent mother-infant relationship and the developing infant. This topic has received great attention in the research literature over the past three decades, and much has been learned about depression in mothers as a risk factor for offspring. However, many questions about when and how depression is associated with problematic parenting impacting on offspring remain unanswered. In fact, there have been inconsistent findings on outcomes of infants of mothers suffering from depression, and there is a need for studies investigating potential factors moderating the adverse effects which have been reported in some studies. Moreover, PPD has repeatedly been viewed as a unitary construct, thereby overlooking that PPD-mothers may not be a homogenous group; and that this may play an important role, not only in understanding the mechanisms of risk, but also for whom the association between maternal depression and adverse offspring outcomes may be stronger.

The present PhD-thesis adds to the existing research by investigating two potential maternal moderators of risk: maternal personality functioning and adult attachment state of mind. Related to this, the question of the meaningfulness of considering early environment being of particular importance versus other possible mechanisms is addressed. Two indicators of infant psycho-social functioning at one year are considered in relation to this: Infant-mother attachment quality as measured by the Strange situation procedure (Ainsworth, Blehar, Waters, & Wall, 1978) and global indices of infant development as measured by the Bayley Scales of Infant and Toddler Development, third edition, (Bayley, 2006; 2010).

As the primary focus in this thesis is on the complex nature of PPD as a risk-factor, less attention is given to differences between specific domains of child developmental outcomes, for example effects of PPD on cognitive outcomes versus psychiatric or socio-emotional outcomes. While not ignoring that specificity in relation to child outcomes in itself is an important issue, the central discussion in this thesis focuses on PPD as a risk-factor for overall psycho-social functioning in offspring.

The thesis consists of two parts: (1) three academic articles (enclosed in Appendices II-IV) and (2) the main body of the thesis connecting the articles to a thematic context, summarizing the accumulated results, and discussing the PhD-project's central concepts. This part has the following outline: First, postpartum depression will be defined and conceptualized, followed by a discussion of maternal postpartum depression as a risk factor for offspring, leading to a presentation of the overall research questions addressed in the current thesis. Next, the overall design of the study and measures employed will be presented. Following, the three research papers will be summarized, including a presentation of the specific research questions and study hypotheses addressed in the separate studies. Finally, the findings will be discussed and main conclusions stated. As the three empirical papers have been integrated in the second part, verbatim overlap will occur to some degree.

Maternal postpartum depression

Defining postpartum depression

The term 'maternal postpartum depression' (PPD) generally refers to depressive episodes that are prevalent following childbirth. On the face of it, this is a straightforward definition. However, the definitions of the 'postpartum' period as well as 'depression' vary across diagnosis classification systems and research studies, which in fact makes it rather imprecise. According to the current version of the Diagnostic and Statistical Manual of Mental Disorders 5th edition (DSM-5:American Psychiatric Association, 2013), the diagnostic criteria for a major depressive episode of depression must be met together with an onset of the disorder within four weeks after delivery. International Classification of Diseases 10th edition (ICD-10: World Health Organization, 1992), also requires that diagnostic criteria for depression (i.e. mild, moderate or severe depression) are met, but instead of the four weeks specifier, the ICD-10 considers six weeks after delivery to be the appropriate onset window. However, the meaningfulness of these definitions of the postpartum period have repeatedly been questioned (Jones & Cantwell, 2010; Munk-Olsen, Laursen, Pedersen, Mors, & Mortensen, 2006; National Collaborating Centre for Mental Health, 2007; Stowe, Hostetter, & Newport, 2005), and consequently, in clinical practice and in many research studies, time frames of up to one year postpartum have been used to define the postpartum period (see for example, www.postpartum.net/ Professionals-and-Community/Marce-Society-Position-on-Assessment-and-Screening.aspx, Gavin et al., 2005). A growing body of evidence suggests that up to 50% of postpartum depressive episodes actually begin prior to delivery (for example, Stowe et al., 2005), and DSM-5 has recognized this by changing the DSM-IV listing from a postpartum onset specifier to also include an onset during pregnancy, thus referring collectively to peripartum depressive episodes (American Psychiatric Association, 2013). The present thesis, however, does not deal with this broader concept of perinatal depression, but primarily focuses on depression identified after delivery.

Even though it was carried out in Denmark, where the ICD-10 is the standard for classifying mental disorders, in the present study depression is understood according to the DSM-5 classification and diagnostic criteria. The reason for this is pragmatic and based on the fact that the majority of the PPD research literature uses the DSM framework. Moreover, the majority of research currently conducted in Denmark uses DSM to classify psychiatric disorders. Thus, for the

sake of clarity and to make it more feasible to compare results, in this thesis the term depression/depressive episode is generally used in accordance with to the DSM classification.

Despite the generally accepted definitions of PPD as an episode of depressive disorder according to diagnostic criteria (as assessed in a diagnostic interview), in large parts of the research literature self-report measures are used to assess depression. This way depression is often measured in a continuous manner (i.e. focusing on the severity of depressive *symptoms* instead of the presence or absence of a depressive *disorder*), and often this approach involves including subclinical levels of depression. Also, this approach implies that the DSM-IV notion of minor depression[1] and the ICD-10 diagnosis of mild depressive episode often are included in studies. In line with this, O'Hara and MacCabe (2013:380) define postpartum depression as 'any major or subsyndromal depression present any time during the first year after delivery'. This will be the framework within which PPD will be understood and discussed in this thesis.

Prevalence

Due to the varying definitions of depression and the time windows under consideration, prevalence estimates for PPD have ranged widely. An early meta-analysis based on 59 studies, including both self-report and interview-based measures of depression, and considering the postpartum period to be up to eight weeks postpartum, found an overall prevalence of 13% (O'Hara & Swain, 1996). It is noteworthy that it was found that studies using self-report assessment of PPD yielded larger estimates of prevalence than studies that only used clinical interviews, suggesting that self-report measures may overestimate the prevalence. In their meta-analysis of 28 studies, Gavin et al. (2005) only included studies that assessed depression using a structured clinical interview, thereby only including incidents of depression according to diagnostic criteria. When using an onset-window of three months postpartum, they found that up to 7.1% of new mothers may experience a major depressive episode and, when including minor depression, the prevalence estimate increased to 19.2%. In a more recent European study, 1,066 women were followed from pregnancy to 12 months postpartum (Banti et al., 2011). In this study a diagnostic interview was used to assess depression, and the postpartum period was defined as the first year postpartum. The results indicated that 9.6%

[1] 'Minor depressive disorder is given in the DSM-IV-TR as an example of a Depressive Disorder Not Otherwise Specified (American Psychiatric Association, 2000). It is a mood disorder that does not meet full criteria for major depressive disorder but in which at least two depressive symptoms are present for two weeks. It overlaps to some extent with the ICD-10 classification 'mild depressive episode'.' However, DSM-5 omits minor depressive disorder.

of new mothers may experience a major depressive episode during the first year after delivery. No estimates were given for minor depression.

Studies comparing the prevalence of depression among non-childbearing women with prevalence of depression during the postpartum period may be relevant when discussing PPD. Though the findings have been mixed, such studies help to contextualize the findings of prevalence of depression among postpartum women, and address the question of whether the postpartum period represents a period of increased risk. Some early studies found that depression following childbirth did not appear to exceed the incidence of depression found in non-childbearing populations (O'Hara, Lewis, Schlechte, & Varner, 1991; Cooper, Campbell, Day, Kennerley, & Bond, 1988). Though the rates of depression (i.e. depressed or not) did not differ for postpartum women as compared with non-bearing women, the findings from these studies suggested that postpartum women present significantly higher symptom levels as compared with non-bearing depressed women. However, two more recent large-scale studies indicated that the postpartum period may in fact be a time of increased risk of depression (Vesga-López et al., 2008; Davé, Petersen, Sherr, & Nazareth, 2010). Of note, Vesga-López et al. only found that the postpartum period represented a period of increased risk when adjusting for 'general depression risk factors' (see also below). This may suggest that, together with risk factors generally assumed to increase the risk of depression, childbirth and motherhood must be considered as a distinct psychosocial stressor and risk factor for depression.

Despite varying estimates of prevalence and the inconclusive evidence for proposing that the postpartum period represents a period of particular risk for depression, it may be emphasized that experiencing depression in the postpartum period is rather common; and considering the potential negative consequences for the new mother, her family, and her child, PPD must be considered a major public health issue.

Risk factors

Numerous studies have investigated what factors might predict who is at risk of PPD, including three meta-analytic studies (Beck, 2001; O'Hara & Swain, 1996; Robertson, Grace, Wallington, & Stewart, 2004). In general, factors assumed to increase the risk of depression outside the postpartum period also predict PPD. These include low socioeconomic status (SES), in particular poverty, previous depression and anxiety, general health, and stressful life events. Factors such as unwanted

pregnancy, perinatal complications, difficult infant temperament, poor social support, poor marital relationships and being single have been identified as additional risk factors of PPD. In the meta-analysis by Robertson et al. (2004), maternal personality characteristics, such as neuroticism and negative attributional cognitive style, for example, being 'a worrier', being nervous, ruminating, and pessimistic, were also found to be predictors of PPD. More recent large-scale studies have underlined the importance of perinatal-related stressors, such as prenatal hospitalization and emergency caesareans, poor health and difficult temperament of the infant, as well as low SES (Wang, Wu, Anderson, & Florence, 2011; Vik et al., 2009).

High levels of depressive symptoms and high levels of recurrence

As mentioned above, previous research has suggested that one difference between depression following delivery and depression in non-postpartum women is that the severity of symptoms tend to be higher in this particular period (see also Augusto, Kumar, Calheiros, Matos, & Figueiredo, 1996). Considering the dramatic changes that characterize the perinatal period, such as sleep deprivation, changes in appetite, and changes in hormone levels, this may not seem surprising. However, it is also possible that issues specifically related to becoming a mother/caregiver and establishing a close relationship to an infant may be particularly distressing to some new mothers (Brockington & Guedeney, 1999; Bifulco et al., 2004a; Tyano, Keren, Herrman, & Cox, 2010), thus resulting in the very high depression scores.

Another important feature of PPD is that, like major depression occurring in any period of a person's life, for a large group of mothers, PPD is likely to be recurrent or to persist over a long period of time (McLennan, Kotelchuck, & Cho, 2001; Josefsson & Sydsjö, 2007; Cooper, Murray, Wilson, & Romaniuk, 2003). For example, in a large-scale prospective study, Josefsson and Sydsjö (2007) found that women with a history of postpartum depressive symptoms were approximately six times more likely to have subsequent depressive symptoms outside the postpartum period, compared to women who did not have depressive symptoms in the postpartum period. Similarly, Copper et al. (2003) found high rates of recurrent depression among PPD mothers, even when effectively treated at four months postpartum. In another study, based on the same sample, Murray et al. reported that at 16 years postpartum, only four out of 58 PPD mothers were never subsequently depressed after four months postpartum (Murray et al., 2011).

This research is not only important in terms of providing sufficient help and long-term monitoring of mothers experiencing PPD, but also in terms of evaluating findings on effects of PPD on offspring. As I will discuss below, the fact that a large group of PPD mothers experience recurrent episodes of depression throughout the child's life often makes it difficult to disentangle effects of depression in the postpartum period from effects of later, recurrent or chronic maternal depression.

The multifaceted nature of postpartum depression as a risk factor for offspring

Like depression that occurs outside the postpartum period, PPD creates personal suffering and weakens the mother's overall ability to function well in many spheres of life. What differs, however, is that a woman suffering from PPD also faces the challenges of motherhood and the responsibility of taking care of a young infant. As a result of the negative affects, behaviors and cognitions which are part of having a depression, it has been proposed that a mother with depression in the postpartum period is in increased for being an inadequate social partner and to be unable to meet the child's social and emotional needs (Goodman & Gotlib, 1999). Accordingly, over the past three decades, numerous studies have examined whether PPD might affect the emerging mother-infant relationship and subsequent psycho-social outcomes in the child. A wide range of child outcomes have been examined in relation to PPD. These include studies of maternal and/or infant interactive behavioral characteristics or patterns of regulation during mother-infant interaction, indicators of socio-emotional development (such as behavioral and emotional regulation and infant-mother attachment), general indices of development (including cognitive, language[2], and early motor development[3]), and psychiatric outcomes (often divided into internalizing and externalizing problems).

Across studies, PPD has consistently been found to be associated with less optimal early mother-infant interactions. During interaction with their infants, mothers suffering from PPD are more likely to be withdrawn and/or intrusive (Field, Hernandez-Reif, & Diego, 2006) and they are less likely to display sensitive parenting behavior as compared with non-depressed mothers (Feldman et al., 2009; Murray, FioriCowley, Hooper, & Cooper, 1996). Likewise, early interactive patterns in PPD dyads appear to be less contingent and less optimal in terms of regulating infant

[2] In many studies language development and cognitive development are not viewed as separate entities, and are often collectively referred to as 'cognitive development'.

[3] Motor development is usually not viewed as an indicator of general development after infancy and toddlerhood (where it is usually viewed as part of the overall 'psycho-motor development'). Therefore motor development is rarely considered after toddlerhood in the context of PPD.

affective states than in non-depressed dyads (Beebe et al., 2007; Friedman, Beebe, Jaffe, Ross, & Triggs, 2010; Tronick & Reck, 2009). Finally, infants of depressed mothers have been found to show more social withdrawal and lower activity levels, not only when interacting with their mother, but also during interactions with sensitive strangers (Burtchen et al., 2013; Cohn, Campbell, Matias, & Hopkins, 1990; Field, 1995).

Such features of maternal and infant interactive behaviors are generally assumed to be important factors in healthy developmental outcomes in children (Beebe et al., 2010; Hane, Fox, Henderson, & Marshall, 2008; Madigan et al., 2006; Madigan, Moran, Schuengel, Pederson, & Otten, 2007; Milne, Greenway, Guedeney, & Larroque, 2009; Murray, 2014). For example, insensitive and unresponsive parenting has consistently been documented to be one of the most important predictors of insecure infant-mother attachment (Leerkes, 2011; Van IJzendoorn, 1995) and of infant's difficulties in developing effective self-regulation skills (Calkins & Leerkes, 2004; Davidov & Grusec, 2006; Cassidy, 1994; Tronick & Reck, 2009); and contingent responses, mutual activities, and parental attention to infant activity and attention are assumed to be predictive of infant cognitive development (Grusec & Davidov, 2010; Murray, 2014).

However, when reviewing the literature on the effects of PPD on subsequent developmental outcomes in the child, the diversity among studies is striking. For example, with respect to cognitive development, whereas a group of studies have found links between PPD and poor cognitive development in children, a considerable number of studies have failed to detect effects. Hay et al. (2001) found an effect of brief PPD on children's IQ at four and 11 years of age; Cogill et al. also found a significant adverse effect of PPD on children's cognitive functioning when they were four years old (Cogill, Caplan, Alexandra, Robson, & Kumar, 1986); Murray et al. (1996; 2011) detected an effect of PPD on boys' cognitive development at 18 months and on male adolescents' academic performance at 16 years of age; and recently, a study showed that infants of depressed mothers had stable lower cognitive scores when tested at six, 12, and 18 months of age as compared with infants of non-depressed mothers (Azak, 2012). By contrast, Keim et al. (2011) did not find an association between PPD and cognitive development at 12 months; Piteo, Yelland, and Makrides (2012) found no effects on either cognitive, language, or motor development at 18 months; in their very large sample Kurstjens and Wolke (2001) could not find any effects of PPD on child cognitive development at 20 months, five years or seven years, not even when mothers were chronically depressed throughout the first seven years; and finally, a recent large-scale study failed to detect any independent effect of PPD on child IQ at eight years of age (Evans et al., 2012).

Instead, the authors of this study concluded that maternal depression may effect child development whenever it occurs from pregnancy over the first three years postpartum.

Similarly, findings regarding the impact of PPD on the quality of the mother-child attachment relationship have been contradictory. Whereas some studies have found independent effects of PPD on infant-mother attachment quality (Murray et al., 1996; Righetti-Veltema, Bousquet, & Manzano, 2003) regardless of whether the mother remitted, other large-scale studies have found no links between PPD and attachment quality at one year (Tharner et al., 2012) or at 36 months of age (Campbell et al., 2004). In the latter study, only children of women with late, intermittent, or chronic depressive symptoms who were also low in sensitivity had a heightened risk of insecure attachment.

The need to move beyond main effect models

Given such divergent findings, many researchers have questioned the meaningfulness of trying to explain the risk of adverse child outcomes in terms of main effect models, in which a single factor such as PPD is assumed to predict outcome (Goodman & Gotlib, 1999; Sohr-Preston & Scaramella, 2006). Hence, in accordance with accumulative risk theories (Greenberg et al., 1999; Sameroff & Fiese, 1999), it has been proposed that rather a combination of several risk factors may predict children's long-term developmental problems. In a meta-analysis of 193 studies examining associations between maternal depression and problematic child outcomes, Goodman et al. (2011) examined a wide range of potential moderators of effects of maternal depression on offspring. The results clearly demonstrate that a large part of the variability among studies may be explained by moderating factors, such as family context and child characteristics. Though the studies were not limited to studies of PPD but included studies of maternal depression occurring at any time during childhood, the overall conclusions of this study are likely also to hold for studies of PPD. It is noteworthy that the results showed that whereas other family characteristic moderators (such as parent's divorce) revealed specificity depending on the particular child outcome, poverty seemed to enhance the risk of adverse developmental outcomes regardless of the assessed domain of child development. Accordingly, the most consistent associations between PPD and adverse child outcomes have been found in high-risk populations in which the depressive symptoms occurred in combination with poverty (Hay et al., 2001; Lyons-Ruth, Lyubchik, Wolfe, & Bronfman, 2002; Belsky & Fearon, 2008).

An early 'sensitive' period of development or persistence and later depression effects?

The diversity among findings has also led researchers to question whether maternal depression confined to the postpartum period in itself can have a long-term impact on child development, or whether any such effects might be mediated by other factors, such as ongoing exposure to maternal depression (Brennan et al., 2000; Evans et al., 2012; for two reviews, see: Grace, Evindar, & Stewart, 2003; Brand & Brennan, 2009). Thus, an important moderating factor may be the duration and persistence of depression.

For example, the findings of Josefsson and Sydsjö (2007) showed that both PPD and current depressive symptoms were related to disturbed behavior in the children at four years of age, as measured by maternal report. However, when they compared children of mothers with (a) no depressive symptoms, (b) only PPD, (c) only current depressive symptoms, and (d) both PPD and current depressive symptoms, the results revealed that children of mothers with only PPD did not differ from the non-depressed group. Instead, children of mothers with only current depressive symptoms as well as children of mothers with both PPD and current depressive symptoms were more likely to show disturbed behavior at four years of age.

These findings accord with a study examining effects of PPD on psychiatric outcomes in offspring at 13 years of age (Halligan, Murray, Martins, & Cooper, 2007). In this study it was found that adolescents whose mothers had PPD showed more affective disorders than adolescents whose mothers did not have PPD. However, when taking into account depression occurring after the child reached the age of five (defined as 'late depression'), the independent effects of PPD were no longer evident. Neither adolescents whose mother had PPD but not depression after five years nor adolescents whose mother only had late depression showed elevated rates of affective disorders compared to adolescents of mothers without depression. Only if the mother had both PPD and late depression was there an increased risk of more affective disorders in the child.

Fihrer, McMahon, and Taylor (2009) specifically addressed the question of the importance of the early environment versus exposure to ongoing maternal depression. They examined how various characteristics of depression (i.e. severity and recurrence over time) affected child outcomes, and whether any effects of early depression on child outcomes were mediated by the mothers' depression at the time of the assessment. The outcomes in this study were child internalizing and externalizing problems at six to eight years of age, as reported by mothers, fathers, and teachers in

questionnaires as well in a semi-structured diagnostic interview with the mother. Overall, PPD was related to later internalizing and externalizing problems, and the severity of maternal depressive symptoms was related to behavior problems in the child seven years later. However, the effects of PPD on externalizing problems were fully mediated by concurrent maternal depressive symptoms, which themselves had a unique effect on externalizing behavior. Thus, PPD only had an indirect effect on child externalizing behavior by increasing the risk of later depression. By contrast, concurrent maternal depressive symptoms did not mediate the effects of early depression, i.e. maternal concurrent depression did not reduce the extent to which PPD explained the child's current internalizing problems.

In a study based on the same sample used in the study by Halligan et al. mentioned above, Murray et al. (2011) also addressed the question of effects of PPD only versus recurrent/ongoing depression in explaining offspring depression at 16 years of age. In this study, subsequent maternal depression and marital conflict were found to be partial mediators of the effects of PPD, together with insecure infant-mother attachment and low ego-resilience at eight years. Interestingly, only maternal depression accumulating for 17 or more months after the postpartum period (versus 1-7 months and 8-16 months) added significantly to the risk of developing depression in the adolescent. Despite the added risk of maternal subsequent depression lasting more than 17 months, an independent effect of PPD was not eliminated. Thus, in this study, the authors argue for a unique effect of PPD on later psychiatric problems (in this case, depression/internalizing problems), regardless of subsequent maternal depression.

Might underlying maternal factors play a role in explaining divergent outcomes?

Taken together, the findings from these studies reflect the complexity of interacting factors in the child's environment in explaining outcomes. Also, regardless of whether or not PPD results in an increased risk of adverse child outcomes independently of other factors, these findings stress the importance of taking into account later maternal depressive symptoms when claiming longitudinal unique effects of PPD. Furthermore, findings from longitudinal studies monitoring subsequent depression in PPD-mothers clearly demonstrate that a large group of children of mothers with PPD are not only exposed to maternal depressed mood in the first months of their life; they repeatedly face the consequences of having a depressed parent. At the same time, the studies discussed above also demonstrate that another group of children whose mothers had PPD does not seem to differ

from children of non-PPD mothers in terms of healthy psychosocial development. Nevertheless, in the light of the findings of Murray et al. (2011) and Fihrer, Evindar, and Steward (2009) – though they are not conclusive – it is difficult to rule out the possibility that PPD in itself may put offspring at increased risk, particularly with respect to internalizing problems.

That said, it is also likely that it is not only the timing, the amount of exposure, or manifest depressive symptoms that explain why some children of depressed mothers are at greater risk of a wide range of negative outcomes and others are not. It has recently been argued that the difficulties in parenting often observed among depressed mothers may also reflect other often co-occurring difficulties rather than depression *per se* (Goodman, 2014; Sellers et al., 2014). Goodman (2014) proposes that it is probably also the characteristics or qualities that distinguish women with recurrent depression, relative to a single episode, that matter to children. For example, in the study discussed above by Fihrer and colleagues, a substantial number of mothers in their sample reported moderate to severe depressive symptoms at five study time points during the first eight years after delivery. As stressed by the authors, such a pattern of ongoing or recurrent depression may reflect underlying personality pathology, though this is not dealt with in their study.

The potential role of personality disorders in relation to major depressive disorder is well established within adult psychiatry, especially in the case of recurrent depression (Bagby, Quilty, & Ryder, 2008; Enfoux et al., 2013; Friborg et al., 2014). Furthermore, as previously mentioned, maternal personality characteristics have been found to be a risk factor when it comes to PPD (Robertson et al., 2004). Nevertheless, the influence of co-concurrent personality disorder in relation to PPD and child outcomes has only rarely been examined.

In one of the few studies which has done so, it was found that co-morbid personality disorder (PD) moderated the effect of PPD on early parental care and infant dysregulated behavior at 18 months of age (Conroy, Marks, Schacht, Davies, & Moran, 2010; Conroy et al., 2012). Infants of mothers with only PPD or only PD did not differ from infants of mothers with neither condition. The importance of taking into account persistent underlying factors was also highlighted in a recent study of 299 dyads in which mediators of the association between maternal recurrent depression and offspring psychopathology was examined (Sellers et al., 2014). In this study maternal parenting qualities (i.e. hostility and low warmth) were found to mediate the effects of depression. However, when co-occurring maternal antisocial behavior was included in the analysis, the effect of maternal depression was no longer evident. Though not specifically examining effects of PPD, but specifically focusing on mothers with a history of recurrent depressive disorder, the results of this study demonstrated that parenting problems may not be an inevitable consequence of maternal

depression. Instead, the authors argue that parent-child problems may be better understood in the context of co-existing maternal problems.

Findings from two studies by McMahon and colleagues based on the same sample as that used in the above-mentioned study by Fihrer, McMahon, and Taylor (2009) accord with these studies. The McMahon studies demonstrated that adult insecure attachment (as assessed in Adult Attachment Interview, AAI: George, Kaplan, & Main, 1985) was related to persistent or recurrent depression at least until the child's preschool age and that maternal attachment moderated the association between PPD and infant-mother attachment (McMahon, Barnett, Kowalenko, & Tennant, 2006; McMahon, Trapolinia, & Barnett, 2008). Infants of mothers with PPD with a secure state of mind regarding attachment did not display more infant-mother attachment insecurity than infants of non-depressed mothers. Thus, maternal insecure state of mind both seemed to be associated with persistent and recurrent depression and seemed to interact with PPD in increasing the risk of infant-mother attachment insecurity. These findings have also been supported in a study of early mother-infant interaction in PPD dyads. In this study it was found that adult attachment security protected the mother-child interaction from the negative impact of PPD (Flykt, Kanninen, Sinkkonen, & Punamäki, 2010).

Both personality disorder and adult attachment insecurity are considered to be associated with depressive disorder and recurrence of depression (Bakermans-Kranenburg & van IJzendoorn, 2009; Bifulco et al., 2004b; Kendell, 2002; McMahon et al., 2008; Newton-Howes et al., 2014). Moreover, in numerous studies, attachment researchers have demonstrated that adult state of mind regarding attachment may play an important role when it comes to predicting the quality of parenting behavior and the quality of the infant-mother attachment relationship (for a review see Hesse, 2008, and for a meta-analysis see Van IJzendoorn, 1995). Although the link between personality disorder and parenting behavior has not been as intensively studied as in the case of AAI-classifications, in fact, a recent systematic review of 11 studies identified parental personality disorder as a serious risk factor for impaired parenting (Laulik, Chou, Browne, & Allam, 2013). Thus it can be argued that PD and adult attachment security are important factors to consider when examining the effects of PPD on offspring.

To sum up: the existing research is not conclusive regarding the question of whether early exposure to maternal depression can have a lasting adverse effect on the developing child, or whether long-term effects may be due to other mechanisms. This may be due to the fact that PPD is often recurrent or persistent, leaving unanswered the question of whether an early sensitive period is especially important to infant development. Furthermore, previous findings indicate that underlying

psychological vulnerabilities such as personality pathology and adult attachment insecurity may be important factors in understanding which mothers may experience recurrent or persistent depression, but also in understanding when and how PPD impact negatively on offspring. However, strikingly few studies have in fact examined PPD populations with respect to such vulnerabilities, leaving the question of how underlying maternal psychological factors may magnify or buffer effects on the developing mother-infant relationship largely unanswered.

The present study

This thesis addresses the issues discussed above in three empirical studies. In the first study (PhD paper 1), we addressed 'the heterogeneous nature of PPD', i.e. we investigated the extent to which mothers presenting elevated depressive symptoms two to three months postpartum also presented co-occurring psychological difficulties, such as higher levels of personality disorder and adult attachment insecurity compared to mothers who did not present postpartum depressive symptoms. In the second study (PhD paper 2), we examined early concurrent and long-term effects of PPD on general indices of infant development (i.e. cognitive, language, and motor development), thereby addressing the question of early environmental effects of PPD versus other potential factors predicting outcome. Finally, in the third study (PhD paper 3), we investigated the role of maternal personality disorder in the association between PPD and infant-mother attachment.

Method

In this section I will present the overall research context of the current thesis. More detailed descriptions of sampling strategy, selection-criteria, procedures, flow of participants, statistics, and measures are provided in the three research papers.

Sample

The PPD-study constituting the empirical research in this thesis was embedded in an on-going longitudinal research project in the Copenhagen University BabyLab (CU BabyLab). Within a non-clinical population and using a micro-analytic approach, the overall objective of the CU BabyLab research was to study the role of non-verbal features in mother-infant interactions during the first year after birth in relation to transgenerational transmission of attachment (Væver, Harder, Køppe, Hansen, & Delafield-Butt, 2010). Mothers were recruited during pregnancy via advertisement on internet pages and at local general practitioners. Sixty-four first-time mothers with no psychopathology were initially enrolled in the CU BabyLab-project. Out of these, 60 dyads participated until the child was 13 months of age, and this sample constituted the comparison group in this thesis.

We recruited mothers with elevated postpartum depressive symptoms for the index group (PPD group) in collaboration with public healthcare nurses from central Copenhagen. During a routine home-visits two month after delivery, the nurses screened for postpartum depressive symptoms (self-report). If a first-time mother scored above cut-off for probable depression, and if interested, the nurse would refer her to the CUB for an information meeting and further assessment. All PPD-mothers were offered (a) a six-session psychotherapeutic cognitive-behavioral group-based intervention, and (b) two psychotherapeutic video-feedback sessions after recordings of mother-infant interaction which were part of the overall research project. The latter were conducted at infant age 4 and 13 months. Forty-four mothers were referred, and 32 mothers and their infants were initially enrolled. Two mothers dropped out during baseline assessments, and one mother dropped out after 4-months assessments, resulting in a sample of 30 PPD-dyads at baseline and 29 PPD-dyads at 13 months.

Table 1
Maternal and Infant characteristics at baseline

Variables	PPD group (*n*= 30)	Non-clinical group (*n*=60)	*P*
Maternal age at delivery, years, *M* (SD)	30.47 (4.075)	30.55 (4.010)	.927
Maternal age range	22-39	23-43	
Parents not living together, *n* (%)	1 (3.3)	1 (1.7)	.558
Maternal years of education, *n* (%)			.403
9-12 (ISCED[1] level 1-3)	3 (10.0)	4 (6.7)	
14 (ISCED level 4)	2 (6.7)	5 (8.3)	
15 (ISCED level 5 and 6)	15 (50.0)	21 (35.0)	
17 or more (ISCED level 7 and 8)	10 (33.3)	30 (50.0)	
Maternal occupational status, *n* (%)			.474
Unemployed	4 (13.3)	5 (8.3)	
Maternal nationality, *n* (%)			.682
Danish	27 (90,0)	56 (93.3)	
Neighboring European countries	3 (10.0)	4 (6.7)	
Infant gender, *n* (%)			.823
Female	14 (46.7)	31 (51.7)	
EPDS-score[1]	15.8 (4.0)	4.9 (4.4)	.000
10 or more on EPDS	30 (100)	5 (8.3)	.000
DSM-IV depression diagnosis, n (%)			.000
None or minimal depression	2 (6.6)	60 (100)	
Minor depression	2(6.6)	-	
Major depression	26(86.7)	-	
Gestational age at birth, weeks, *M* (SD)	40.1 (1.3)	40.6 (1.2)	.181
Gestational age at birth, range	38.3 - 42.1	38.1-42.4	
Infant Birth weight, g., *M* (SD)	3447.26 (437)	3572.53 (510)	.248
Birth weight, range, g.	2730 – 4600	2620 – 4900	

Note: ISCED= International Standard Classification of Education by UNESCO.
[1] EPDS administered at 8-10 weeks (PPD-group), and at 6-8 weeks postpartum (Non-clinical group)

Table 1 shows that the two groups did not differ in terms of standard demographic considerations, which justifies using the BabyLab sample as an appropriate comparison group for the PPD sample. Furthermore, Table 1 shows that, overall, the mothers were highly educated, by far the majority of them were employed, and only one mother in each group was single. The infants had normal birth weights and were born at term, the latter being a result of the sampling strategy. In sum, this confirms that our sample must be considered a low-risk sample.

Measures

Figure 1 shows timeliness and measurements used in the current thesis. In this section, together with a listing of measures, I will provide some general considerations not appearing in the papers, yet relevant for the overall thesis. This includes considerations regarding appropriateness for choice of child-outcome measures as indicators of infant mental health. More detailed descriptions of the measures are provided in the research papers.

Maternal depression

We used the Danish version of the Edinburgh Postnatal Depression Scale (EPDS: Cox, Holden, & Sagovsky, 1987; Nielsen, Videbech, Hedegaard, Dalby, & Secher, 2000) to screen for postpartum depressive symptoms in the comparison group six to eight weeks postpartum, and it was also used by the healthcare nurses as a basis for referral to the PPD group.

The standardized psychiatric interview, present state examination (PSE: Wing, Cooper, & Sartorius, 2012), was used in both groups at baseline. In the comparison group PSE was used for the sampling to ensure that the women did not present any other current psychiatric symptomatology in accordance with the DSM-IV definition of Axis-I psychopathology, such as anxiety disorders, depressive disorders, bipolar disorders, eating disorders, somatoform disorders, and schizophrenia or other psychotic disorders. In the PPD group, PSE was used to validate depression diagnoses and ensure that the mothers did not present any psychiatric disorder prior to depression.

Originally, PSE was developed to assess mental disorders in accordance with ICD criteria (Wing, Cooper, & Sartorius, 1974), and therefore we initially coded the interviews using the ICD

10 criteria. However, as mentioned previously, the present research uses DSM classifications, and therefore the interviews were re-coded in accordance with the current version of DSM at the time the data was collected, i.e. DSM-IV. As the general diagnostic criteria for major depressive episodes have not been changed in DSM-5, studies using DSM-5 criteria for major depression are comparable with our data.

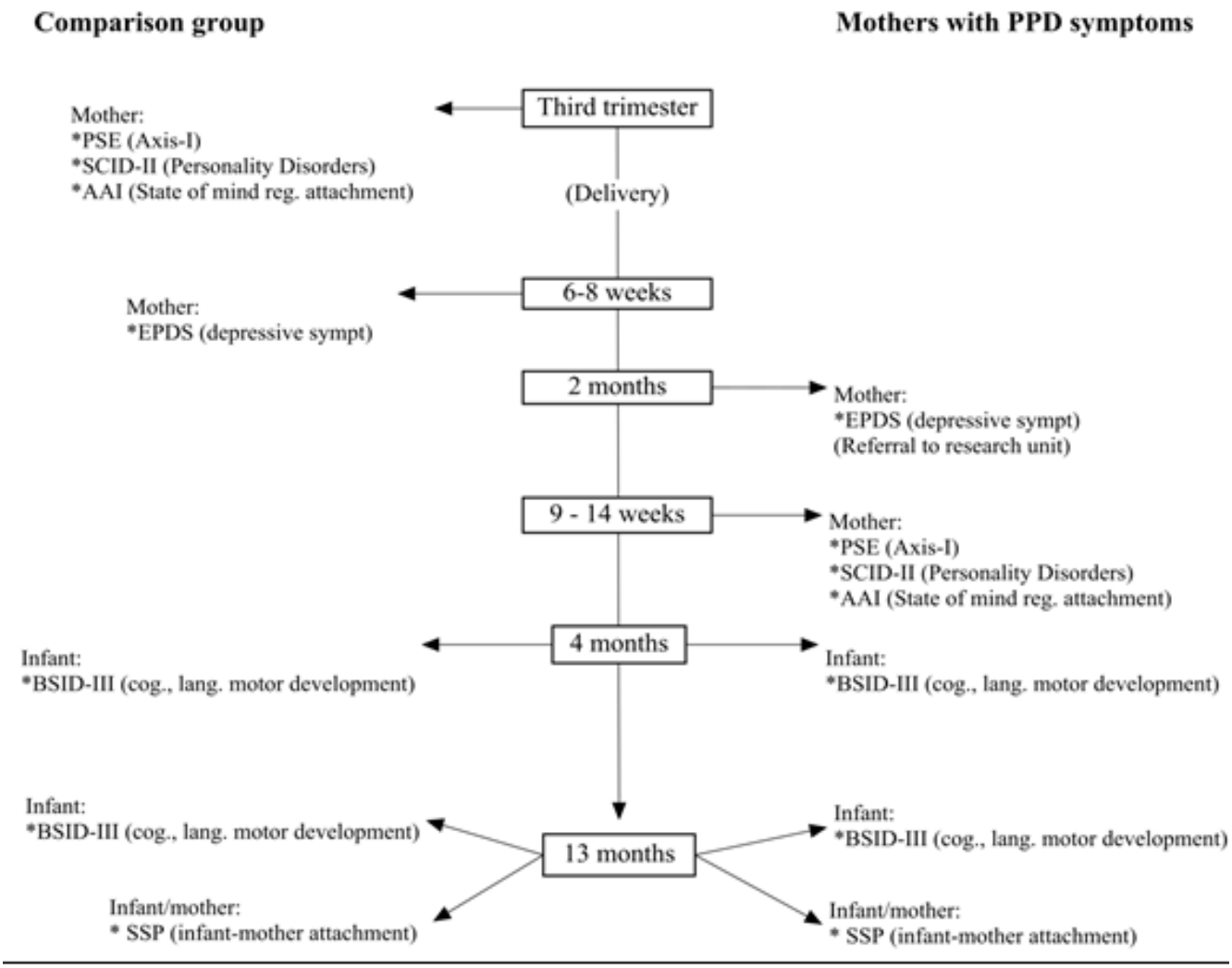
In relation to the changing of ICD-10 diagnoses into DSM-IV diagnoses of depression, a few considerations are worth mentioning. Generally, 'major depression' according to DSM-IV criteria is equivalent to the ICD-10 classifications of 'moderate and severe depression'. In most instances, patients who qualify for the ICD-10 diagnosis 'mild depressive episode' will not qualify for the diagnosis 'major depressive episode' according to DSM-IV/5. However, in some instances, the ICD-10 diagnosis of 'mild depressive episode' will in fact qualify for the DSM-IV/5 diagnosis 'major depressive episode': the situation in which two of the three symptoms listed for ICD-10 F32.0 Criterion B are met and three additional symptoms from Criterion C are met; five symptoms in total, which is the minimum number of criteria that must be met to qualify for a major depressive episode according to DSM-IV (World Health Organization, 1992; American Psychiatric Association, 2000). In our sample, one mother who qualified for the ICD-10 diagnosis 'mild depressive disorder' in fact qualified for the DSM-IV diagnosis 'major depressive episode'.

Maternal personality disorders

Co-occurring maternal personality pathology was assessed in the Structured Clinical Interview for DSM-IV Axis-II (SCID-II: Gibbon, Spitzer, & First, 1997). In the comparison group, SCID-II was administered in the third trimester after enrollment, scheduled on the same day as the PSE. In the PPD group, SCID-II was also planned on the same occasion as the PSE, but in most cases, the SCID-II was rescheduled for a separate occasion. Often the PSE in itself lasted 1½ - 2 hours. Also, in many cases the mothers brought the babies to the interviews, which frequently had to be stopped due to the baby becoming fussy, etc.

As DSM-5 no longer operates with the multiaxial system in DSM-IV, the widespread distinction between Axis-I and Axis-II psychopathology (in which Axis-I represented acute mental disorders needing treatment as exemplified above and Axis-II represented persisting personality

Figure 1. Overview and timeliness of measurements used in the current thesis



Note: PSE = Present State Examination. SCID-II = Structured Clinical Interview for DSM-IV Axis-II personality disorders. AAI = Adult Attachment Interview. EPDS = Edinburgh Postnatal Depression Scale. SSP = Strange Situation Procedure

dysfunction not better accounted for by an Axis-I disorder) is no longer appropriate (American Psychiatric Association, 2000; American Psychiatric Association, 2000; American Psychiatric Association, 2013). However, the data for the present research project was collected before DSM-5 was published. Therefore, personality disorders were diagnosed according to DSM-IV criteria. Accordingly, the terms Axis I and Axis II are used in the research papers.

Although the notion of Axis II disorders is no longer appropriate, the general criteria for personality disorders in DSM-5 have not changed from those in DSM-IV, and the three PD clusters

A, B, and C[4] have also been retained. Therefore, the results reported in this thesis are generally comparable with current and future studies based on DSM-5 criteria for diagnosing personality disorders. Nevertheless, a few additional considerations may be relevant in the context of comparing our results with results based on DSM-5 criteria.

The DSM-IV classification Personality Disorder Not Otherwise Specified (PDNOS), which was the most frequently observed PD in our sample, has been replaced with Other Specified Personality Disorder and Unspecified Personality Disorder in DSM-5. This classification can be used in two situations: "1) the individual's pattern meets the general criteria for a PD […] but the criteria for any specific personality disorder are not met; or 2) the individual's personality pattern meets the general criteria for PD, but the individual is considered to have a personality disorder that is not included in the DSM-5 classification' (American Psychiatric Association, 2013: 646). Following Verheul, Bartak, and Widiger (2007), we used PDNOS when a mother did not meet the diagnostic criteria for any specific PD, but met five or more criteria across the specific PDs, causing significant impairment in functioning. This is in accordance with the DSM-5 classification Unspecified Personality Disorder, and therefore, the frequently observed PDNOS-category in our sample is comparable with the DSM-5 classification Unspecified Personality Disorder.

In addition to the DSM-IV/5 personality disorders, SCID-II can be used to diagnose Passive-aggressive Personality Disorder and Depressive Personality Disorder. DSM-5 considers the latter two to be examples of the diagnosis Other specified Personality Disorder. In the current sample Passive-aggressive PD was not used, but Depressive PD was relevant in three instances. According to DSM-5 criteria this PD would have been counted as instances of Other Specified Personality Disorder. Finally, it should be noted that when categorizing Depressive PD according to clusters, we considered it to be a Cluster C disorder.

Maternal state of mind regarding attachment

The Adult Attachment Interview (AAI: George et al., 1985) together with the standard approach to rating and classifying the interview (Hesse, 2008; Main, Goldwyn, & Hesse, 2003) was used to assess maternal state of mind regarding attachment. In the comparison group AAI was administered

[4] Cluster A (the 'odd' or 'eccentric' cluster) comprises paranoid, schizoid, and schizotypal personality disorders. Cluster B (the 'dramatic' or 'emotional' cluster') comprises antisocial, borderline, histrionic, and narcissistic personality disorders. Cluster C (the 'anxious' or 'neurotic' cluster) comprises avoidant, dependent, and obsessive personality disorder.

in the third trimester after enrollment on a separate occasion. In the PPD group, the AAI was administered after enrollment on a separate occasion and scheduled 9 to 12 weeks postpartum. If the mother did not have a babysitter, the BabyLab provided childcare during the interview.

Infant outcome measures

Two indicators of infant psychosocial functioning were used as outcome measures in paper 2 and paper 3. Both measures are considered important indicators of current and future mental health.

To measure infant developmental status at four and 13 months, we used the Danish version of the Bayley Scales of Infant and Toddler Development, third edition, (BSID-III: Bayley, 2006; Bayley, 2010). The BSID-III is widely used in research and clinical practice to assess the general development of infants and toddlers, i.e. cognitive, language, and motor development. Scores on the BSID-III are important because they contain a valid indication of the infant's current developmental status. Likewise, scores on the BSID-III (and older versions) have been found to be predictive of cognitive functioning later during childhood (Dilalla et al., 1990; Lung, Chen, & Shu, 2012; Lung, Shu, Chiang, Chen, & Lin, 2009).

We used the Strange Situation Procedure (SSP: Ainsworth, Blehar, Waters, & Wall, 1978) to assess infant-mother attachment relationship. Attachment quality is assumed to be closely related to the early development of emotion-regulation capacities (Cassidy, 2008; Calkins & Leerkes, 2004). Likewise, a large body of evidence has suggested that the quality of early attachment relationships plays a vital role in the child's social-emotional functioning and adaptation throughout childhood and adolescence (for a review, see Thompson, 2008), and consistently, attachment insecurity and in particular disorganization has been found to be related to externalizing, internalizing, and peer-related problems (for three recent meta-analyses, see Fearon, Bakermans-Kranenburg, van IJzendoorn, Lapsley, & Roisman, 2010; Groh et al., 2014; Groh, Roisman, van IJzendoorn, Bakermans-Kranenburg, & Fearon, 2012).

Summaries of papers

Paper 1: EPDS Scores, Adult Attachment Interview Responses, and Personality Disorders

Based on the observation that the findings have so far been mixed with respect to establishing consistent associations between PPD and adverse psycho-social child outcomes, the overall objective of this study was to address the question of homogeneity among women suffering from PPD. That is, we examined the extent to which mothers presenting postpartum depressive symptoms differed from non-depressed mothers in terms of co-occurring psychological vulnerabilities assumed to be associated with an increased risk of compromising the developing relationship between mother and child. Thus, the primary aim was to examine whether women referred on the basis of a score within the clinical range of the EPDS two to three months postpartum (referred group) would show (a) more insecure states of mind regarding attachment and (b) higher levels of personality pathology compared to women scoring within the non-clinical range (non-clinical group). Additionally, we explored associations between state of mind regarding attachment, personality pathology and postpartum depression

The results revealed that the groups differed with respect to state of mind regarding attachment (Fisher's exact test: p = .029; Cramer's V= 0.33). Mothers with high EPDS-scores were more likely to have a preoccupied insecure state of mind (x^2 [1] =7.96, p = .008). Based on the odds ratio, the odds of referred mothers being preoccupied were 8.07 times higher than for non-clinical mothers (95% CI = 1.56 to 41.83, p = .01). The distributions of AAI-classifications are shown in Table 2.

Table 2
Summary of maternal attachment AAI classifications (4-way)

	Referred group (*n*=30)			Non-clinical group (*n*=55)		
AAI classification	%	Observed count	Expected count	%	Observed count	Expected count
Secure (F)	60.0	18	19.1	65.5	36	34.9
Dismissing (Ds)	16.7	5	7.1	27.3	15	12.9
Preoccupied (E)	23.3	7	3.2	3.6	2	5.8
Unresolved (U)	0	0	0.7	3.6	2	1.3

Note: AAI = Adult Attachment Interview

Mothers in both groups had symptoms of personality disorder, and for both groups symptoms of PD were most frequently observed in Cluster C. However, as shown in Table 3, referred mothers had significantly more symptoms of personality disorder within each of the three PD-clusters. In terms of fulfilling criteria for a PD diagnosis, mothers with high EPDS-scores were significantly more likely to have one or more PD than mothers with low EPDS-scores, with 53.3 % (n = 16) versus none of non-clinical mothers meeting diagnostic criteria for one or more PD (X^2 [1] = 36.14, p < .001). Furthermore, a positive correlation between the two variables EPDS-score and total number of SCID-II criteria met across all PDs (i.e. symptoms of PD without necessarily fulfilling criteria for any PD), was found (r = .63, n = 85, p = .000) demonstrating high levels of co-morbidity between postpartum depressive symptoms and symptoms of PD.

Table 3.
Number of SCID-II criteria met within cluster A, B, and C in referred and non-clinical mothers

	Referred group (n=30)		Non-clinical group (n=55)				
	M	*SD*	*M*	*SD*	p-value	95% CI	Cohen's *d*
Cluster A	0.67	1.6	0.02	0.1	0.03	[-1.2 ; 0.1]	0.91
Cluster B	0.77	1.5	0.07	0.3	0.02	[-1.3 ; -0.1]	0.94
Cluster C	4.7	3.7	0.22	0.6	0.000	[-5.9 ; -3.1]	2.07

Note: SCID-II = Structured Clinical Interview for DSM-IV Axis II.
Cluster A = Paranoid, Schizoid, and Schizoid personality disorder.
Cluster B = Antisocial, Borderline, Histrionic, and Narcissistic personality disorder.
Cluster C = Avoidant, Dependent, Obsessive-Compulsive, Depressive, and Passive-aggressive PD.

Finally, associations between state of mind regarding attachment, personality pathology, and postpartum depressive symptoms were explored. Chi-square tests and ANOVAs showed no significant associations between PD (diagnosis and symptoms) and AAI (secure/insecure), AAI (four-way), or AAI (preoccupied/non-preoccupied). Thus, no association between AAI-classification and personality pathology was found. However, multiple regression analysis revealed that personality disorder and AAI-classification were independently related to the EPDS-score (preoccupied AAI-classification, B = 6.94, SE = 1.65, p < .001; PD-diagnosis, B = 9.71, SE = 1.30, p < .001) and that these two factors together accounted for 48% of the variance in EPDS-score (Table 4). Preoccupied AAI classification in itself accounted for 13% of the variance in EPDS-scores. When PD diagnosis was entered into the model, this accounted for an additional 36% (R^2 change F[1.82] = 55.95, p = .000).

Table 4

Multiple regression analysis predicting symptoms of postpartum depression from AAI-responses and the presence of one of more personality disorder

	EPDS-score			
Predictor	*B*	*SE B*	*β*	R^2 Change
Step 1				.13**
Constant	0.14	2.44		
Preoccupied vs non-preoccupied	7.32	2.13	.35**	-
Step 2				.36***
Constant	-1.28	1.90		
Preoccupied vs non-preoccupied	6.94	1.65	.34***	
One or more PD	9.71	1.30	60***	

Note: Total adjusted R^2 = .47. * p < .05. ** p < .01 *** p < .001.
EPDS= Edinburgh Postnatal Depression Scale. PD = Personality Disorder.

Paper 2: Early Concurrent and Long-Term Effects of Postpartum Depression

In this study we examined early concurrent and long-term effects of maternal postpartum depression on cognitive, language, and motor development in infants of clinically depressed mothers. This study was the first to examine early concurrent effects of PPD at four months of age, i.e. at the time when infants are actually exposed (or have recently been exposed) to maternal depressive symptoms. Thus, we implicitly addressed the question of whether the early environment is of particular importance, or whether early effects might be caught up if/when the mother remits. We hypothesized that infants of mothers with clinical depression three to four months postpartum (a) would have poorer developmental outcomes at four months of age compared to infants of non-clinical mothers; (b) that they would also have poorer developmental outcomes at 13 months; and (c) that this association would be moderated by gender, with boys of mothers with depression showing greater developmental delays than girls of mothers with depression at both four and 13 months of age. We adjusted all analyses for maternal level of education and child gender because these factors have found to be predictive of child outcome as measured by the BSID-III (Koutra et al., 2012) and the BSID-II (Wu et al., 2008). Moreover, all analyses were controlled for co-morbid maternal PD.

At four months we found developmental differences on the BSID-III between infants of PPD mothers and the non-clinical group. MANOVA revealed a significant multivariate effect for group status (Wilks' Λ = .83, F[5,70] = 2.83; p = .02). As shown in Table 5, infants of PPD mothers had lower scores on the cognitive scale than infants of non-clinical mothers at four months of age,

adjusting for maternal education, maternal co-morbid PD and infant gender (F[1,74] = 5.50, p = .02, Cohen's d = 0.8). No overall effects of infant gender, maternal education, or maternal co-morbid personality disorder were found, and the interaction term between PPD and child gender was not significant.

Table 5
Infant developmental outcome (BSID-III) at four months by group status

	PPD n=28		Controls n=53		
Outcome	Mean	SE	Mean	SE	p[a]
Cognitive	9.18	.47	10.8	.38	.003
Language, receptive	9.94	.46	9.8	.37	.845
Language, expressive	9.34	.33	9.06	.27	.367
Fine motor	10.69	.54	11.29	.44	.319
Gross motor	11.27	.31	10.86	.26	.235

Note: Estimated means taken from models not including interaction terms. [a]Adjusted for maternal education, infant gender, and maternal co-morbid personality disorder.

At 13 months no differences in BSID-III scores between the PPD group and infants of non-clinical mothers were found for infant cognitive, language, or motor development. Analysis including maternal concurrent depressive symptoms at 13 months in the model did not change the results, and concurrent depressive symptoms were not related to BSID-III scores. However, at this time, only six PPD mothers scored within the clinical range of the EPDS, limiting statistical power with respect to investigating potential effects of concurrent/recurrent at 13 months. As with the four-month findings, there were no main effects of maternal co-morbid PD or education, and no moderating effect of infant gender was found. However, regardless of depression, a significant multivariate main effect for infant gender was found at 13 months of age (Wilks' Λ = .83, F[5,71] = 2.87; p = .02). Boys scored significantly lower on both language subscales than girls the effect size being large.

Paper 3: Postpartum Depression, Personality Disorders, and Infant Attachment

Based on our finding reported in paper 1 that more than half of the PPD-mothers in our sample presented co-morbid personality pathology, in this study we set out to examine whether infants of mothers with co-concurrent PD were at greater risk of attachment insecurity and disorganization at one year of age than infants of mothers with only PPD and infants of mothers with no psychopathology.

The results showed that the majority of infants in both groups was securely attached, i.e. 65.6% of infants in the PPD group and 66.1% of the infants in the non-clinical group. No differences were found with respect to the conventional ABCD-classifications. However, as shown in Table 6, when using continuous outcome measures, we found differences in attachment security scores between the three diagnostic groups (F[2]= 3,77, p = .027, R^2 = .104). Infants of mothers with both depression and PD had significantly lower security scores (Mean *z*-score = -0.69, SE = 0.32) than infants of non-clinical mothers (Mean *z*-score = -0.09, SE = 0.23, p =.037) and infants of mothers with depression only (Mean *z*-score = 0.26, SE = 0.27, p = .009). Further analysis revealed that infants of mothers with depression only did not differ from infants of non-clinical mothers in attachment security. No differences were found between the three groups with respect to infant disorganization scores.

Table 6
Infant attachment security and disorganization by maternal diagnostic status

		Attachment security, z-score[a]				Attachment disorganization, z-score[b]			
	n		*F* (df)	*p*	R^2		*F* (df)	*p*	R^2
Maternal diagnostic status	85		3.77 (2)	.027	.104		0.78	.463	.074
		Mean (SE)	*B* (SE)	*p*		Mean (SE)	*B* (SE)	*p*	
Non-clinical	52	-0.09 (0.23)	Ref	-		-0.35 (0.24)	Ref	-	
Depressed only	17	0.26 (0.27)	0.35 (0.29)	.231		0.01 (0.28)	0.34 (0.29)	.257	
Depressed + PD	16	-0.69 (0.32)	-0.60 (0.28)	.037		-0.19 (0.33)	0.16 (0.29)	.581	

Note: Results of Analyses of Co-Variance with planned contrasts. Means are estimated marginal means.
[a] adjusted for infant gender, maternal unemployment status, and level of education.
[b] adjusted for infant gender, maternal unemployment status, and age, level of education.
PD = one or more personality disorder. Ref = Reference group.

Finally, to test whether our findings could be explained by higher depression scores in the group of mothers with comorbid PD, additional ANOVAs were conducted. We found similar levels of depressive symptoms in mothers with only depression (M = 14.65, SD = 0.82) and mothers with comorbid PD (M = 16.25, SD = .178). This suggests that the presence of PD, and not differences in depressive symptoms, accounted for the higher rates of infant attachment insecurity in the group of mothers with both postpartum depression and PD.

Discussion

In this thesis maternal postpartum depression has been studied as a risk factor for early indicators of infant mental health. Previous research has demonstrated that PPD may result in adverse psycho-social outcomes in children. However, what is not well understood is the extent to which difficulties in parenting reflect parental depression *per se* or other commonly co-occurring associated maternal difficulties.

Postpartum depression – not a unitary construct

The first study (PhD paper 1) demonstrated that even in a sample of well-resourced mothers, women with elevated levels of depressive symptoms differed significantly from mothers with low depression scores with respect to levels of personality pathology and adult attachment security. Furthermore, this study demonstrated that another large proportion of the PPD-mothers did not present these difficulties with 46.6% of PPD mothers not having a personality disorder and 60% being classified as secure in the AAI.

Although personality functioning and state of mind regarding attachment do not necessarily reflect the same underlying construct, in concurrence with previous findings (Apter, Devouche, Gratier, Valente, & Le Nestour, 2012; McMahon et al., 2006; Murray, Halligan, Adams, Patterson, & Goodyer, 2006) these results may indicate that PPD is not a unitary construct; i.e. that PPD-populations are in fact very heterogeneous with some PPD-mothers struggling with persistent co-occurring difficulties while others 'only' present depressive symptoms. Confirming Murray et al.(2006)'s findings, the difference between PPD and comparison-mothers in our sample indicated that maybe in particular the preoccupied AAI-classification is associated with PPD. Whereas the only previous study examining associations between PPD and personality disorder found high correlations between PDs within Cluster B (Apter et al., 2012), mothers in our sample primarily presented PD symptoms in the less severe Cluster C. This difference is most likely due to the fact that in Apter et al.'s study, mothers were recruited from a clinical high-risk setting. By contrast, our low-risk sample was recruited from a non-clinical setting.

PD and AAI insecurity – overlooked risk-factors of PPD?

Previous research on risk factors for PPD focused primarily on "external" risk factors, such as poor social support, and marital relationship, low SES status, and stressful life events (see for example, O'Hara, 2013). Robertson et al. (2004) did in fact identify maternal personality characteristics, such as neuroticism and cognitive attributional style, as predictors of PPD. However, considering the cumulating evidence linking both attachment insecurity and personality disorder to depression in adults in general (Bakermans-Kranenburg & van IJzendoorn, 2009; Corruble, 2009; Corruble, Ginestet, & Guelfi, 1996) it is striking how understudied these factors are within PPD-research. Also, with respect to increased risk for recurrent depression and poor long-term treatment outcomes, both PD and adult attachment insecurity have been found to play a significant role (Daniel, 2006; Daniel, 2014; McMahon et al., 2008; Newton-Howes et al., 2014).

While discussing personality disorders and AAI-responses in relation to PPD it is important not to ignore the fact that SCID-II and AAI are thought to capture different constructs. Adult attachment insecurity is characterized by the speaker's lack of coherence when asked about early attachment relationships. Personality disorders, on the other hand, are diagnosed by inquiring about (distorted) perceptions of self and others as well as persistent and pervasive interpersonal problems across contexts. The rational for evaluating whether a PD criteria is met, is to a larger extent based on the patient's descriptions of actual behavior in different situations than it is the case when rating AAI-responses. However, the two constructs indeed also share important features. Chronic relationship-oriented difficulties, interpersonal stress, and affect-regulation problems are assumed to be at the core of both personality dysfunction and adult attachment insecurity (Simpson et al., 2011; Lyddon & Sherry, 2001; Lyddon & Sherry, 2001; Brennan & Shaver, 1995; Conklin, Bradley, & Westen, 2006). Moreover, both the insecure AAI-classifications and PDs are generally assumed to be the result of an interaction between the individual and his/her environment, and adverse childhood experiences within the close caregiving context are thought to play a particularly significant role (Hesse, 2008; Paris & Tyrer, 1996). That insecure adult attachment patterns and PD most likely are interrelated phenomena is confirmed in research linking insecure attachment in both children and adults to the development of PD (Brennan & Shaver, 1998; Crittenden & Newman, 2010; Lyddon & Sherry, 2001; Sherry, Lyddon, & Henson, 2007). In particular, disorganized (in children) and unresolved (in adults) attachment are considered to predict personality pathology. In fact, some PDs have been found to be remarkably strongly associated with specific AAI-classifications. For example, the preoccupied AAI-classification has been found to be

overrepresented in individuals with borderline personality PD (Fonagy et al., 1996), and antisocial and avoidant PD have been associated with the dismissing AAI-classification (Lyddon & Sherry, 2001; Sherry et al., 2007).

To the best of our knowledge, our study was the first study to examine both PD and adult attachment status in the same sample in relation to PPD. In the light of the above mentioned research, it might seem surprising that no association between PD and AAI-classifications were found in our sample, especially because the difference between AAI-classifications across non-PPD and PPD-mothers was due to the preoccupied category being over-represented among PPD-mothers. Given Fonagy et al.(1996)'s findings, one would expect preoccupied attachment patterns to be associated with borderline PD. However, in our sample no such association was found. Instead, PD and AAI-classification were independently related to EPDS-score, suggesting that the mothers who were classified as preoccupied in the AAI were not the same who fulfilled criteria for PD. Furthermore, as mentioned, PD-symptoms were primarily observed in Cluster C in our sample, and though we did observe symptoms of borderline PD, no mother fulfilled the diagnostic criteria for borderline PD (or any other Cluster B disorder). Whether or not the preoccupied mothers in our sample represented a more well-functioning subgroup of preoccupied women than the preoccupied women in Fonagy et al.(1996)'s sample – who were all diagnosed with borderline PD – is beyond the scope of this thesis to evaluate.

Nevertheless, confirming previous studies in which PPD was associated with PD (Apter et al., 2012) and state of mind regarding attachment (McMahon et al., 2006; Murray et al., 2006), the current study provides some evidence that PD, even within Cluster C, and adult attachment insecurity, maybe in particular the preoccupied classification, may be two separate risk factors of PPD.

How is it that some children of PPD-mothers are at-risk and others are not?

The results in PhD paper 1 are not only important in terms of better being able to identify women at risk for developing PPD or at risk for experiencing chronic or recurrent depression. They may also help explain how it is that some children of PPD-mothers seem to be at increased risk for poorer psycho-social outcomes than children of non-depressed mothers. Underlying persistent psychological vulnerabilities in the mother may amplify the effects, and at the same time, high personality functioning and adult attachment security might buffer potential effects of depression.

Accordingly, it has been proposed that the negative parenting behaviors displayed by some depressed mothers, may not be specific to depression, but instead a consequence of other difficulties, such as chronic interpersonal problems or high levels of stress or anxiety even in the absence of depressive symptoms (Lovejoy, Graczyk, O'Hare, & Neuman, 2000).

Impaired capacity for mentalization might be a mechanism explaining both persistent relationship-oriented difficulties and difficulties in affect regulation, and thus a key to understanding why some depressed mothers are able to provide sensitive and appropriate caregiving while others are not. It has been proposed that the capacity for mentalization plays a crucial role in difficulties in affect regulation and interpersonal functioning, not only in close relationships in general, but also within early mother-infant relationships (Lysaker, Gumley, & Dimaggio, 2011; Grienenberger, Kelly, & Slade, 2005; Fonagy, 1999; Fonagy, Gergely, & Jurist, 2002). Mentalization enables the mother to recognize and regulate the infant's affective states as well as to regulate her own emotional distress. Accordingly, studies have found mentalization skills in parents to be an important predictor of infant-mother attachment (Fonagy, Steele, Steele, Moran, & Higgitt, 1991; Slade, Grienenberger, Bernbach, Levy, & Locker, 2005; Kelly, Slade, & Grienenberger, 2005) as well as a mediator between the quality of mother-infant affective communication and infant-mother attachment quality (Grienenberger et al., 2005). Moreover, parental mentalization has been found to predict children's emotion regulation capacities (Fonagy et al., 2002) and good metalizing on the part of the caregiver is associated with higher performance of children in social cognition tasks well children's social-cognitive development (Laranjo, Bernier, Meins, & Carlson, 2010; Meins et al., 2003; Meins et al., 2002; Meins, Fernyhough, Arnott, Turner, & Leekam, 2011). A mother with low capacity for mentalization may be less able to regulate her own affective states when facing the challenges of taking care of a young infant, she may be less likely to correctly identify the infant's needs, and she may be more likely to be guided by her own perspectives rather than to take the infant's perspective. As a result, mothers with both PPD and low capacity for mentalization may display more insensitive parenting behaviors, and be less efficient in regulating the infant's affective states in comparison with mothers with no depression or mothers with depression but still good capacities for mentalization.

Effects of PPD independent of other factors?

In PhD paper 3 the importance of taking into account underlying maternal difficulties was further stressed. While McMahon et al. (2006) have already shown that adult attachment insecurity can

moderate effects of PPD in relation to infant-mother attachment, no previous studies have considered co-morbid PD when examining effects of PPD on infant-mother attachment.

Confirming our study hypothesis, we found that infants of PPD-mothers with co-occurring PD were significantly more likely to be insecurely attached to their mother than infants of mothers who only had PPD or infants of mothers with no psychopathology. Of note, infants of mothers only suffering from PPD were not more likely to be insecurely attached at one year than infants of mothers with no psychopathology. Moreover, mothers with both PD and PPD did not differ from mothers with only PPD with regard to depression scores, suggesting that the elevated levels of infant-mother attachment insecurity could not be explained by higher depression scores. The idea that PPD in itself might not be a risk-factor for problematic parenting and adverse child outcomes is supported by Conroy et al. (2010; 2012)'s findings. In their sample of 200 dyads, evidence for PPD as a risk-factor for impaired caregiving practices at two months and infant dysregulated behavior at 18 months was only found if the mother also presented PD. In this study, neither mothers with PPD only nor mothers with PD only has a greater risk for adverse outcomes.

Further support for the idea that maternal depressive symptoms *per se* might not explain why some infants are at increased risk for adverse outcomes comes from research evaluating treatment of PPD in terms of benefit for the mother-infant relationship and child outcomes. Results from such studies suggest that even when maternal depressive symptoms are effectively treated in psychotherapy, this does not necessarily result in a beneficial effect for long-term child outcomes. For example, findings from a randomized controlled trial showed that three different psychotherapies (cognitive-behavioral therapy, psychodynamic therapy, and non-directive counseling) were all efficient with regard to reducing maternal depressive symptoms at 4½ months postpartum, immediately after treatment. However, although an immediate effect on maternal sensitivity during mother-infant interaction was evident, no long-term benefits for infant-mother attachment and cognitive development at 18 months was found. Furthermore, psychotherapeutic treatment did not reduce the risk for subsequent episodes of postpartum depression (Cooper et al., 2003; Murray, Cooper, Wilson, & Romaniuk, 2003). Results from another randomized controlled trial by Forman et al. (2007) similarly found that even though interpersonal psychotherapy significantly impacted on depressive symptoms and reduced parenting stress, no benefits for infant social-emotional outcomes at 18 months were found. Instead, early maternal negative perceptions of the child predicted poor child outcomes. Findings from other treatment trials, in which the interventions did not focus on reducing maternal depressive symptoms but instead on improving mother-infant relationship provide further support for this notion. Though in these studies maternal

depressive symptoms and recurrence of depression were not reduced, these trials showed that long-term adverse child outcomes, such as poorer child cognitive development and insecure attachment, were prevented by targeting intervention specifically on the mother-infant relationship (Cicchetti, Toth, & Rogosch, 1999; Cicchetti, Rogosch, & Toth, 2000; Cooper et al., 2009; Toth, Rogosch, Manly, & Cicchetti, 2006).

Indeed, Murray and colleagues (2003) speculated that the fact that treatment in their study only resulted in short-term benefits to the mother-infant relationship reflected that underlying maternal vulnerabilities persisted despite symptomatic improvement. Our findings may suggest that such vulnerabilities might be co-occurring PD. As discussed above, low capacities for mentalization is likely to be a significant feature of PD. However, as we in the CU-BabyLab currently do not have data on maternal capacity for mentalization, we cannot draw any conclusions regarding this. Future research at the CU- BabyLab will bring us closer to an understanding of whether maternal capacity for mentalization can explain why some infants of mothers with both PD and PPD are at greater risk for insecure attachment.

Does the postpartum period represent a 'sensitive period'?

In PhD-paper 2 we studied effects of PPD on infant development as measured by the BSID-III at four months and at 13 months, i.e. we addressed the question whether early effects – if any – might be enduring throughout the first year after birth. In this study we only included mothers from the PPD-group who fulfilled criteria for clinical depression as it has been suggested that non-clinical levels of depression might not be associated with lower scores on measures such as the BSID-III (for example, Piteo, Yelland, & Makrides, 2012; Grace et al., 2003). The main finding in PhD-study 2 was that although a significant adverse effect of clinical depression in the postpartum period was found for cognitive development at four months, no adverse effects of PPD were evident at 13 months. Findings remained the same when adjusting for maternal level of education, unemployment status, and concurrent depressive symptoms at 13 months. Contrary to our findings in PhD-study 3 we did not detect any increased risk for adverse outcomes among infants of mothers suffering from both PPD and PD.

One conclusion that may be drawn from these findings is that maternal depression can have an acute concurrent effect on early cognitive development in infants, but that this effect is not necessarily persisting if the mother remits. The fact that only six of the PPD-mothers scored above 10 on the EPDS at 13 months suggested that the majority of PPD-mothers had recovered from

depression at the second time when we assessed infant development (i.e. at 13 months). Thus, these findings do not support the notion of early environment being of particular importance for later development. A recent large-scale study by Evan et al.(2012), examined associations between depression occurring from pregnancy until three years postpartum and child cognitive development at 8 years. In line with the conclusions drawn in this study, a valid interpretation of our findings is that maternal depression may have adverse effects on child development whenever it occurs, however, the early postpartum period does not seem to represent a period of particular risk. Though not yet examined in our study, our findings may also be consistent with previous findings suggesting that chronicity and recurrence of depression together may increase the risk for poorer cognitive development in children (Brennan et al., 2000; Kurstjens & Wolke, 2001; Murray et al., 1996). Future research monitoring maternal depressive symptoms and infant development over the course of child development in the current sample can address whether the early effects detected in our sample might be related to later development though not evident at 13 months.

How can the current findings be understood as a whole?

On the face of it, the findings in paper 2 and paper 3 may seem contradictory. However, as discussed in Paper 2, it is possible that problematic parenting behaviors important for infant-mother attachment security may not affect other domains of infant development as measured in the BSID-III. The BSID-III does not capture infant behaviors during the test situation, for example irritability, social withdrawal, or infant positive/negative interaction with the tester. Neither does it capture other indicators of social-emotional development, such as emotion-regulation capacities which are assumed to be correlated with attachment quality (Calkins & Leerkes, 2004). Accordingly, Murray and colleagues did not find any main effects of PPD on child cognitive development at 18 months or at five years; still, adverse effects of PPD were evident for infant-mother attachment at 18 months, and social-emotional development at five years (Murray, Sinclair, Cooper, Ducournau, & Turner, 1999; Murray, Hipwell, & Hooper, 1996).

In line with this, it has been proposed that specific parenting behaviors are likely to support different domains of child development (Bornstein & Tamis-Lemonda, 1997; Grusec & Davidov, 2010; Murray, 2014). For example, infant-mother attachment security is thought to be facilitated by parental sensitivity during distress (Leerkes, 2011), whereas cognitive and language development is thought to be supported by parenting behaviors such as attention to infant activity and attention, scaffolding infant capacities, and book sharing (Grusec & Davidov, 2010; Murray, 2014). Thus,

problematic parenting might interfere with healthy child psycho-social function in some developmental domains while others are not affected. In the current sample consisting of highly educated mothers with almost all the infants growing up with both their mother and farther, it is possible that mothers (and fathers) were able to support general development in the infant despite potential difficulties in maternal affect-regulation and depressive symptoms in the postpartum period resulting in more attachment insecurity among infants of mothers with co-occurring PD.

Taken together our findings are in accordance with cumulative risk models (Goodman & Gotlib, 1999; Greenberg et al., 1999; Sameroff & Fiese, 1999; Rutter, 1999) which propose that when we wish to understand the development of psycho-social problems in children we should not point selectively to a single predictor, such as PPD. Rather, multifactorial causation is likely to explain adverse outcomes in children. In their integrative model for the transmission of risk to children of depressed mothers, Goodman and Gotlib (1999) argued that a range of co-occurring risk factors might moderate the associations between maternal depression and adverse child outcomes. These included the timing and course of maternal depression, the father's mental health and availability, and characteristics of the child (for example, temperament and gender). In a recent comprehensive meta-analytic review of effects of maternal depression on social-emotional and psychiatric outcomes in offspring Goodman and colleagues (2011) concluded that, contrary to other more domain-specific moderators, poverty was a risk-factor amplifying adverse effects of maternal depression on any child outcome. In the current well-resourced sample with access to the ample healthcare and social security services of the Danish society, poverty as a risk-factor was presumably absolutely absent. However, based on Goodman et al.(2011)'s findings and results from studies of effects of maternal postpartum depression on cognitive development (for example (Kurstjens & Wolke, 2001; Koutra et al., 2012; Murray et al., 1996; Piteo et al., 2012) – in which socio-economic factors such as social class and maternal education significantly predicted outcome – it may be argued that in a low-SES sample, adverse effects of PPD probably would have been more pronounced both with respect to infant-mother attachment and BSID-III scores.

Support for the notion of multifactorial causation comes for example from Seifer et al. (1996)'s study in which it was found that maternal psychiatric diagnosis (including major depression) did not predict children's social competence (including a measure of infant attachment) at 14 months. Instead, multiple contextual risks, defined as family functioning, home environment, SES, maternal illness, and adverse life events predicted child outcomes. In concurrence with our findings, the authors concluded that maternal mental illness is not universally associated with adverse child outcomes on all measures. A more recent large-scale study also provides support for

the idea of multiple causation. In this study, the risk for psychiatric disorder in offspring of mothers with recurrent depression, the role of co-occurring psychopathology in mothers with depression was investigated (Sellers et al., 2013). Results revealed that the number of co-occurring psychiatric problems in mothers rather than depression *per se* predicted new-onset offspring disorder.

Limitations and methodological considerations

There are some overall methodological considerations and limitations to this study.

Consequences of different recruitment strategies and potential selection biases

First, the recruitment strategy for the comparison and PPD group respectively differed. Whereas the comparison group was self-referred, the PPD-group was referred by health care nurses. Usually in studies where participants volunteer for a research project, healthier, more well-educated and less distressed individuals are more likely to participate. Although we aimed at recruiting psychological healthy mothers (as reflected by the assessment of concurrent psychopathology at enrollment as part of the sampling via PSE), it is possible that self-referring implied a selection bias in the direction of very well functioned women being over-represented. By contrast, in the PPD-group the selection was based on a screening of all mothers in the five healthcare nurse districts. If a first-time mother scored equal to or above 10 on the EPDS, the nurse would inform her about the project, and if interested, the mother would be referred to the research project. However, as we do not have information regarding how many mothers scored above cut-off, but refused to be referred to the project, nor about what characterized mothers who refused to be referred, we are not able to determine the extent to which this recruitment also implied a sampling bias. Yet, it is likely that new mothers struggling with symptoms of depression but who volunteer for a time-consuming research project represent a more well-functioned subgroup of PPD mothers. Considering that the two groups were highly homogeneous in terms of basic demographic variables (Table 1), it may therefore be argued that the sampling-bias in the comparison group is likely to exist in the PPD-group as well. Hence, it may be argued that the differences found are likely to represent well-resourced PPD-mothers and their infants.

Second, as we aimed at recruiting postpartum depressed mothers for the index/PPD-group, we could not recruit mothers until after delivery, at the time when it was actually possible to screen for PPD-symptoms. However, this implied that baseline assessments (SCID-II and AAI) were conducted at different times across groups, i.e. for the comparison group in third trimester, and for

the PPD-group after the mothers were enrolled, i.e. 9-14 weeks postpartum (Figure 1). Because it was diagnosed during a depressive episode, it could be argued that PD-status might be an artifact of the depression and not a valid reflection of personality pathology. For example, an early study indicated that some personality characteristics, such as interpersonal dependency, can be affected by depression at the time of assessment (Wasek & Endicott, 1983). However, it has been suggested that clinicians who know how to diagnose personality pathology should be able to do so whether or not the patient is simultaneously depressed (Michels, 2010). Moreover, longitudinal studies have found that assessment during a depressive state does not alter the validity of personality disorder diagnosis, in particular when assessed with interview-based instruments such as the SCID-II (Morey et al., 2010; Shea et al., 1996). For example, Morey et al. followed 522 patients over six years, and they found PD-status to be remarkably stable, regardless of whether it was diagnosed while the patient was depressed or not. The same concern might hold for AAI-status. It could be argued that administering the AAI during a depression could influence the response, and that this might account for the higher rates of the preoccupied category. Moreover, it could be argued that the groups are not comparable because the AAI was administered pre- and postpartum in the two groups respectively. However, the AAI has been subjected to a series of psychometric tests of stability (for a review, see Hesse, 2008), and AAI-classifications have been reported to be strikingly stable, even pre and post psychotherapy (see for example, (Levy et al., 2006). Also, Benoit and Parker (1994) found 90% stability between a pre-birth AAIs and AAIs conducted 11 months after birth.

Third, it has been suggested that individuals with dismissing/deactivating attachment strategies are less likely to seek support and help during depression (Dozier, 1990; Mikulincer & Shaver, 2008). Therefore, it may be speculated, that the higher occurrence of preoccupied mothers in our PPD group could reflect that dismissing individuals tend to avoid expressing their distress and/or seek help, for example by underreporting emotional distress when screened with the EPDS by the health care nurses. The same bias could explain the higher occurrence of the preoccupied classification in Murray et al.'s sample. More research is needed to evaluate whether the preoccupied AAI-classification is in fact specifically related to depression following childbirth, or whether also the dismissing category must be considered as a risk-factor of PPD as it is the case of depression more generally (Bakermans-Kranenburg & van IJzendoorn, 2009).

Fourth, because the current PPD-study was integrated into an already ongoing research project of non-clinical dyads, 13-months EPDS-scores were not collected for the first 20 enrolled comparison-mothers, but only for PPD-mothers and the remaining comparison-mothers. As

reported in paper 2, this had the consequence that for analyses including a measure of concurrent depression at 13 months, the comparison-group was reduced to 35 dyads. Considering that an important point in this thesis is the question regarding early versus later depression effects, indeed this is a limitation of the present study. However, due to the fact that only six of the PPD-mothers had elevated scores on the EPDS at this time, sub-group analysis including an 'early PPD + depression at 13 months'-variable (to reflect persistent or recurrent depression) would have been underpowered. Moreover, all PPD-mothers included in analyses for study 2 were clinically depressed at three months postpartum, and even though effects on cognitive development were evident at four months, no effects of depression were evident on the BSID-III at 13 months. Although based on the current data, we cannot make conclusions regarding concurrent depression at 13 months (i.e. using a 'no early PPD but depression at 13 months'), it is very unlikely that a larger sample – or 13-months EPDS-scores for all comparison-mothers – would have changed results for the group of PPD mothers who did not have depressive symptoms at 13 months.

The need for addressing not only moderators but also mechanisms of risk

Fifth, in the current study potential maternal moderators of risk in relation to PPD have been investigated. However, the mechanisms of the transmission of risk have only implicitly been addressed. The occurrence of depressive states, insecure state of mind regarding attachment or personality disorder does not *per se* explain why some children of PPD-mothers are at increased risk for adverse psycho-social development. What matters to children is most likely the cumulated experience from 'real-life' interactions with their primary caregiver(s). Thus, to understand when and how PPD is a risk-factor for the infant, the actual parental behavior during mother-infant interaction must be the focus of investigation. With this focus we might be able to better understand which mechanisms mediate the adverse effects of parental risk-factors such as depression, PD, or adult attachment insecurity. In a sample of 1,364 dyads Wang and Dix (2013) recently investigated such mechanisms. They coded maternal patterns of behavior during mother-infant interactions at 6, 15, and 24 months in PPD-mothers and investigated these patterns as predictors of child outcomes at 36 months. Interestingly, the mothers did not differ with regard to depression severity, however, they adopted significantly different patterns of interactive behavior. Three stable patterns of maternal interactive behavior were identified: Mothers who were highly intrusive, mothers who were both highly intrusive and highly withdrawn (together these were called low-functioning

depressed mothers) and mothers who were both low on intrusiveness and withdrawnness (these were called high-functioned depressed mothers). Overall, patterns of intrusiveness and withdrawn parenting predicted child adjustment at 36 months. However, when comparing children of high functioning depressed mothers with non-depressed, no differences were found for cognitive, language and attachment security, and responsiveness to the mother (although differences with respect to behavior problems and social competence in the children were still evident among children of high functioning depressed mothers). It is very likely that the higher occurrence of insecure attachment among infants of mothers both suffering from PPD and PD in our sample, are mediated by maternal interactive behavioral patterns, such as intrusiveness and withdrawn behavior, and this would be vital to address in future research investigating the role of PPD as a risk-factor for adverse child outcomes.

The need for addressing protective factors in the context of risk

Sixth, the results reported in this thesis are discussed in terms of accumulative risk-models for understanding children's development of psycho-social problems. However, this perspective also implies that children's developmental outcomes are the result of complex interactions between not only risk-factors, but also protective factors buffering adverse effects of a risk factor such as maternal depression. In the current study, the lack of persistent effects on children of mothers only suffering from depressive symptoms in the postpartum period, have been discussed with reference to the low-risk nature of our sample with few concurrent risk-factors. In relation to this we have also explained our findings by arguing that a range of protective factors might have buffered potential adverse effects of PPD. However, strictly speaking, absence of risk-factors is not the same as the presence of protective factors. Thus, the current study would indeed have profited from the assessment of factors assumed to be protective factors potentially buffering negative effects to confirm this. Such factors could be the father's role as a caregiver and as a supportive partner for the mother during her depression, high reflective functioning in both the mother and the father, as well as coping strategies in relation to stressful life-events. All such coping related processes may both buffer mothers from becoming depressed and, once depressed, reduce the likelihood that they will adopt problematic parenting behaviors such as intrusiveness or withdrawn behavior as mentioned above. Child factors such as 'easy temperament' or good capacities for self-regulation which may in turn facilitate maternal feeling of competence and self-efficacy might also be

important protective factors. The broader family- and societal context, including access to social support, healthcare- and mental healthcare services, is also likely to be important buffers.

Research is still limited with regard to investigating protective factors in the context of risk presumably altering the strength of the associations between risk-factors in the child's environment and psycho-social outcomes, and which may facilitate resilience in the developing child. Together with research in potential co-occurring risk-factors, such as maternal PD and attachment status, this should be addressed in future research.

The significant role of child characteristics

Seventh, cumulative risk models have stressed the significant role of taking into account child characteristics when we wish to understand children's psycho-social developmental course (for example, Rutter, 1999). For example, studies using genetically sensitive designs have demonstrated that heritable factors may contribute to the development of psychological problems (Harold et al., 2011; Kim-Cohen, Moffitt, Taylor, Pawlby, & Caspi, 2005; Silberg, Maes, & Eaves, 2010). Moreover, studies have suggested that *in utero* exposure to antenatal psychological distress and depression may predict regulatory problems in offspring as well as poorer psycho-social developmental outcomes regardless of whether the mother develops depression postpartum or not (Evans et al., 2012; Field, 2011; Kingston, Tough, & Whitfield, 2012; van den Berg et al., 2009; Van den Bergh, Mulder, Mennes, & Glover, 2005). Finally, theories of differential susceptibility have proposed that some infants are born more neurobehavioral sensitive to risk-promoting as well as development-enhancing environmental conditions (Del Giudice, Ellis, & Shirtcliff, 2011; Ellis, Boyce, Belsky, Bakermans-Kranenburg, & van IJzendoorn, 2011). Related to this is the discussion of the extent to which environmental effects influence children's behavior versus the extent to which children's behavior impact on their environment. The latter has also been conceptualized as the importance of understanding the reciprocal and transactional relationships within families (Sameroff & Fiese, 1999). The child's characteristics may to a large extent influence his or her own developmental course as a result of the complex interplay between parents and children. In a recent longitudinal study the importance of both taking into account parenting behavior and infant characteristics was further stressed. Using multilevel modeling Planalp and Braungard-Rieker (2013) found evidence to suggest that not only parental sensitivity but also infant temperament explained infant attachment security at 14 months.

As we do not have any data allowing us to investigate potential genetic -, or biological risk in the children (for example, data on neurobehavioral regulatory capacities in the new-born or measures of maternal psychological problems during pregnancy) a limitation of the current study is the lack of taking into account such factors in statistically explaining infant outcomes.

Conclusion and clinical implications

The results of the current PhD-thesis suggest that important risk-factors of developing depression following childbirth may be persistent psychological vulnerabilities such as personality pathology and insecure state of mind regarding attachment. At the same time, our findings have suggested that PPD is not a unitary construct, and that parenting problems and adverse child outcomes may not be an inevitable consequence of PPD. Rather, often co-occurring problems and the context in which the depression occur play important roles in the development of adverse psycho-social problems in children. PPD as a risk-factor for child outcomes is multifaceted and understanding the role of PPD in associations with adverse child outcomes requires that we adopt a nuanced view of the nature of risk to children from maternal depression in the postpartum period. Thus, the findings from this thesis underline the need to move beyond main effect models in explaining effects of PPD on the developing child.

Our findings do not only stress the importance of taking into account co-occurring maternal psychological difficulties when examining associations between PPD and adverse outcomes in offspring – they are also highly important in terms of providing appropriate help to PPD mothers and their infants. Many psychotherapeutic interventions have specifically focused on reducing maternal depressive symptoms. However, a greater attention to attachment related problems, difficulties in close interpersonal functioning, and affect regulation difficulties may prevent psycho-social problems in offspring to a larger extent. For some PPD-mothers the depressive symptoms may not interfere with the mother's abilities to provide sensitive caregiving to the extent that it results in long-term consequences for the child. Although this does not imply that these mothers do not need help, this is reassuring for the group of mothers who only suffer from more transient depressive symptoms in the postpartum period. For another group of PPD-mothers, the depressive symptoms may not be the only factor impacting on the mother-infant relationship and the child's development. Together with the depressive symptoms, such factors might be just as important to target when providing treatment for these PPD-mothers and their infants.

Dansk resumé (Danish summary)

Baggrund: I tre videnskabelige artikler undersøges postpartum depression (PPD) hos mødre som en risiko faktor for mor-barn tilknytningen og barnets generelle udvikling. Tidligere forskningsresultater har været modstridende i forhold til spørgsmålet om, hvorvidt PPD kan have langsigtede negative konsekvenser for barnet. En mulig årsag kan være, at der ikke er blevet skelnet mellem effekter af PPD, som kun forekommer i efterfødselstiden, og effekter af kronisk og tilbagevende depression. Imidlertid kan årsagen også være, at man har overset betydningen af underliggende eller sameksisterende psykologiske vanskeligheder hos moren, som kan moderere sammenhængen mellem PPD og barnets psykosociale udvikling. Denne ph.d.-afhandling fokuserer på to potentielle faktorer hos moren, som kan udgøre sådanne moderatorer: Co-morbid personlighedsforstyrrelse og morens tilknytningsmønster. Spørgsmålet om langsigtede miljømæssige effekter af tidlig PPD versus effekter af tilbagevendende depression gennem barnets udvikling bliver endvidere adresseret. **Metode:** Førstegangsfødende kvinder og deres børn (*N*=90) blev rekrutteret til et langsigtet forskningsprojekt i graviditeten (sammenligningsgruppe) eller to måneder postpartum (PPD-gruppe). Vi undersøgte mødrene med den danske version af Edinburgh Postnatal Depression Scale, og de danske versioner af de kliniske interviews Present State Examination, Structured Clinical Interview for DSM-IV Axis II samt Adult Attachment Interview. Børnene blev undersøgt da de var fire og 13 måneder gamle med den danske version af Bayley Scales of Infant and Toddler Development, third edition. Kvaliteten af tilknytningsrelationen mellem mor og barn blev derudover undersøgt med fremmed situationstesten (Strange Situation Procedure) da børnene var 13 måneder gamle. **Resultater:** Mødre med PPD havde signifikant flere symptomer på personlighedsforstyrrelse og havde større risiko for at have et overoptaget utrygt tilknytningsmønster, end mødre som ikke havde depressive symptomer i efterfødselsperioden (ph.d.-artikel 1). I forhold til effekter på børnene, viste resultaterne at PPD var relateret til dårligere kognitiv udvikling, da de var fire måneder gamle, men ikke da de var 13 måneder gamle (ph.d.-artikel 2), samt at børn af mødre, som både havde personlighedsforstyrrelse og PPD, havde større risiko for at være utrygt tilknyttede, end børn af mødre, som kun havde PPD, eller børn af mødre uden symptomer på psykopatologi. Børn af mødre som 'kun' havde PPD havde ikke forøget risiko for at udvikle utryg tilknytning til deres mor sammenlignet med børn af mødre uden symptomer på psykopatologi (ph.d.-artikel 3). **Konklusion:** Utryg tilknytning og forsinket psykosocial udvikling hos barnet er ikke en uundgåelig konsekvens af PPD. Når vi sætter os for at undersøge effekter af

PPD på barnet, er det afgørende at sameksisterende eller underliggende interpersonelle psykologiske vanskeligheder hos moren med i betragtning. Sådanne faktorer kan ikke blot kan forstærke eller beskytte mod negative effekter af PPD. De kan også forøge risikoen for at depression bliver tilbagevendende eller vedvarende udover efterfødselsperioden, hvilket igen vil forøge risikoen for at depressionen vil få negative konsekvenser for barnets udvikling. Disse resultater er også vigtige, når det handler om behandlingsindsatser. For nogle mødre med PPD gælder det, at de depressive symptomer ikke er den eneste faktor, man bør fokusere på, hvis man ønsker at forebygge negative effekter på mor-barn relationen og barnets udvikling. Her bør indsatsen også fokusere på de mere grundlæggende relationelle vanskeligheder som kan forhindre moren i at etablere et sundt samspil med barnet. For andre mødre med PPD gælder det, at de, på trods af de depressive symptomer, er i stand til at etablere et sundt samspil med deres børn. Og i disse tilfælde synes et mere isoleret fokus på symptomlindring mere rimeligt.

English Summary

Background: In three academic articles, this PhD thesis investigates maternal postpartum depression (PPD) as a risk factor for the infant-mother attachment and infant development. Previous studies have been contradictory with respect to the question of whether PPD can have long term effects on offspring. This may be due to not differing between when PPD is only occurring in the postpartum period and when effects are also due to ongoing or recurrent depression. However, it may also be due to viewing maternal depression as a unitary construct, and not considering underlying maternal psychological difficulties which may moderate potential adverse effects. The present thesis investigates two potential maternal moderators of risk:. Comorbid personality disorder and adult attachment insecurity. Moreover, the question of early environmental effects of PPD versus effects of later or ongoing depression is addressed. **Method:** Mothers (*N*=90) were recruited into a longitudinal study and assessed with Edinburgh Postnatal Depression Scale, and the clinical interviews Present State Examination, Structured Clinical Interview for DSM-IV Axis II, and Adult Attachment Interview. Infants were assessed at four and 13 months with the Bayley Scales of Infant and Toddler Development, third edition. Additionally, at 13 months infant-mother attachment security was assessed using Strange Situation Procedure. **Results:** We found that even in a well-functioned sample, symptoms of depression in the postpartum period was associated with more symptoms of personality disorder and higher levels of a preoccupied insecure state of mind regarding attachment (PhD paper 1). With regard to infant outcomes, we found that PPD was associated with poorer cognitive development at four months but not at 13 month (PhD paper 2) and that infants of mothers with both personality disorder and PPD were at greater risk of developing an insecure attachment relationship with their mother at 13 months than infants of mothers only suffering from PPD or infants of mothers with no psychopathology. Interestingly, infants of mothers who only had PPD were not more likely to be insecurely attachment than infants of comparison-mothers. **Conclusion:** Parenting problems may not be an inevitable consequence of PPD. When investigating effects of PPD on offspring, it is important to take into account co-occurring maternal psychological factors that may not only buffer or amplify effects , but which may also increase the risk of recurrent or persistent depression in the mother. These findings are also important in terms of providing appropriate help with the aim of preventing adverse developmental outcomes in the child. For a large group of PPD mothers, depression may not be the only problem to address. In this case, a focus on the mother-infant

relationship is vital. Another group of PPD mothers seems to be able to provide sensitive caregiving, despite the depressive symptoms. In this case, a more specific focus on reducing depressive symptoms seems more appropriate.

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References

Appendices

Appendix I:

Authorship declarations

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DECLARATION OF AUTHORSHIP

As co-authors of the paper "Links among high EPDS scores, state of mind regarding attachment and symptoms of personality disorders" *Journal of Personality Disorders, (in Press).* which is part of Johanne Smith-Nielsen's PhD thesis, Howard Steele, Heike Mehlhase, Katharina Cordes, Miriam Steele, Susanne Harder, and Mette Væver hereby state that the division of work has been follows:

Johanne Smith-Nielsen (JSN) is the first author of this paper.
She has designed the content in collaboration with Howard Steele, been the main responsible person for collecting clinical data, and wrote the first draft and following versions of the paper. She has conducted the analyses with the guidance of Howard Steele.

Howard Steele is the second author of this paper.
His contributions to the paper were to assist JSN in the development of the original idea and argumentation for the paper, to guide JSN to conduct the relevant analyses, as well as to discuss the results and contents of the paper with JSN. He offered his comments on the first draft, the first submitted version of the paper as well as on the revision of the paper and approved the final manuscript.

Heike Mehlhase is the third author of this paper.
She has conducted codings and reliability of PSE-data and SCID-II-data. Also, Heike Mehlhase has assisted JSN in the preparation of data for analysis, literature search, she has offered her comments on the first submitted version of the paper and she has approved the final manuscript.

Katharina Cordes is the fourth author of this paper.
She has conducted codings and reliability of PSE-data and SCID-II-data. Katharina Cordes has contributed by conducting the initial literature review, she has assisted JSN in conducting parts of descriptive data analyses, she has offered her comments and suggestions on all versions of the manuscript, and she has approved the final version of the manuscript.

Miriam Steele is the fifth author of this paper.
She has contributed to the initial conceptualization and argumentation of the paper, she has discussed results and argumentation of the paper with JSN, and she has approved the final version of the paper.

Susanne Harder is the sixth author of this paper.
Together with Mette S. Væver she was the principal investigator of the overarching mother-infant study in the Copenhagen University Babylab. She has been involved in all stages of the study-

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design of the non-clinical part of the research project, in the reliability codings of AAI-data, she has offered her comments on the first version of the paper, and she has approved the final manuscript.

Mette S. Væver is the seventh author of this paper.
Together with Susanne Harder she was the principal investigator of the overarching mother-infant study in the Copenhagen University Babylab. She has been involved in all stages of the study-design and data collection for both the non-clinical and clinical part of the study. Also, she has offered her comments and suggestions on all versions of the paper, and approved the final manuscript.

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DECLARATION OF AUTHORSHIP

As co-authors of the paper "Effects of maternal postpartum depression in a well-resourced sample: early concurrent and longitudinal effects on infant cognitive, language, and motor development" *Early Childhood Research Quarterly* (under review) which is part of Johanne Smith-Nielsen's PhD thesis, Mette Skovgaard Væver, Anne Tharner, and Marianne Thode Krogh hereby state that the division of work has been follows:

Johanne Smith-Nielsen (JSN) is the first author of this paper.
She has designed the content, been the main responsible person for collecting clinical data, and wrote the first draft and following versions of the paper. She has conducted analyses, though with the guidance of Anne Tharner.

Mette Skovgaard Væver is the second author of this paper.
She was the principal investigator of the overarching mother-infant study at the Copenhagen University Babylab. She has been involved in all stages of the study-design and data collection for both the non-clinical and clinical part of the study Also, she has commented on and offered her suggestions on all versions of the paper, and she has approved the final manuscript.

Anne Tharner is the third author of this paper.
Her contribution to the paper was to assist JSN in conducting the relevant statistical analyses and by critical revising and commenting on the manuscript, and she has approved the final manuscript.

Marianne Thode Krogh is the fourth author of this paper
She has contributed to this paper by recruiting the majority of the non-clinical sample and by collecting the majority of Bayley-data in the non-clinical sample. Also, she has commented on and offered her suggestions on previous versions of the paper, and she approved the final manuscript.

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As co-authors of the paper "Postpartum depression and infant-mother attachment at one year: The impact of co-morbid maternal personality disorder, *Journal of Child Psychology and Psychiatry*, under review", which is part of Johanne Smith-Nielsen's PhD thesis, Mette Skovgaard Væver, Anne Tharner, Howard Steele, Katharina Cordes and Heike Mehlhase hereby state that the division of work has been follows:

Johanne Smith-Nielsen (JSN) is the first author of this paper.
She has designed the content, been the main responsible person for collecting clinical data, and wrote the first draft and following versions of the paper. She has conducted analyses, though with the guidance of Anne Tharner.

Mette Skovgaard Væver is the second author of this paper.
She was the principal investigator of the overarching mother-infant study at the Copenhagen University Babylab. She has been involved in all stages of the study-design and data collection for both the non-clinical and clinical part of the study Also, she has commented on and offered her suggestions on all versions of the paper, and she has approved the final manuscript.

Anne Tharner is the third author of this paper.
Her contribution to the paper was to assist JSN in conducting the relevant analyses, and she has been responsible for the coding of SSP data. Also, she has contributed to the result and discussion sections, she has commented on and offered her suggestions on previous versions, and she has approved the final manuscript.

Howard Steele is the fourth author of this paper.
He has discussed the design, argumentation and data analyses for the paper with JSN. Also, he commented on and offered his suggestions on previous versions of the paper, and he approved the final manuscript.

Katharina Cordes is the fifth author of this paper.
She has conducted codings and inter-rater reliability codings of PSE-data and SCID-II-data. Also, Katharina Cordes has contributed by conducting literature search, she has assisted JSN in writing up parts of the discussion section, she has offered her comments and suggestions on all versions of the manuscript, and she has approved the final version of the manuscript.

Heike Mehlhase is the sixth author of this paper.
Her contribution was to conduct codings and inter-rater reliability codings of PSE-data and SCID-II-data, she has assisted in the preparation of data for analysis, and she has conducted literature

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Appendix II: PhD Paper 1

Journal of Personality Disorders (in-press)

Links among high EPDS-scores, State of mind regarding Attachment, and Symptoms of Personality disorder

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Running head:
High EPDS-scores, Adult Attachment Interview responses, and personality disorders

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Abstract

Underlying persistent psychological difficulties have been found to moderate potential adverse effects of maternal postpartum depression on parenting and infant development. We examined whether mothers presenting postpartum depressive symptoms showed higher levels of personality pathology, and more insecure state of mind regarding attachment compared to non-depressed mothers. Participants (N=85) were assessed with Edinburgh Postnatal Depression Scale (EPDS), Present State Examination, Adult Attachment Interview, and Structured Clinical Interview for DSM-IV Axis II. Mothers with high EPDS-scores were more likely to have a preoccupied insecure state of mind, and to have personality disorder, compared with mothers scoring below clinical cut-off. Furthermore, multiple regression analysis showed that personality disorder and AAI-classification were independently related to EPDS-score, and that these two factors together accounted for 48% of the variance in EPDS-score. Findings are discussed in terms of heterogeneity in PPD populations, and underline the importance of examining potential co-existing psychological difficulties when studying PPD.

Introduction

The Edinburgh Postnatal Depression Scale (EPDS, Cox, Holden, & Sagovsky, 1987) is the most widely used screening instrument for detection of symptoms of depression in the postpartum period (Hewitt, Gilbody, Mann, & Brealey, 2010). Since it was developed, numerous of studies have suggested that universal routine screening with the EPDS is highly recommendable for early detection and referral for postpartum depression (PPD) (for example, Chaudron, Szilagyi, Kitzman, Wadkins, & Conwell, 2004; Murray & Carothers, 1990; Sheeder, Kabir, & Stafford, 2009).

An essential rationale for screening is that PPD is considered to have the potential to disrupt aspects of parental caregiving known to be critical for infant development (for a review, see Field, 2010). However, findings regarding adverse effects on offspring have been inconsistent across studies. Some studies have found effects of PPD on infant-mother attachment (Murray, FioriCowley, Hooper, & Cooper, 1996; Righetti-Veltema, Bousquet, & Manzano, 2003) while others have found no effects (Tharner et al., 2012). Likewise, findings regarding effects on infant development, such as cognitive, language, and motor development, have been inconsistent with some finding small but significant effects (for a review of effects of maternal psychological distress, including effects of PPD, see Kingston, Tough, & Whitfield, 2012), and some finding no effects

(Piteo, Yelland, & Makrides, 2012), or only effects in the case of neonatal at-risk male infants of mothers suffering from chronic depressive symptoms (Kurstjens & Wolke, 2001).

Following, it may be argued that PPD *per se* should not be considered as a severe risk factor of adverse child outcomes, and instead research should focus on the co-existence of risk factors not limited to the postpartum period. It has been suggested that persistent psychological maternal factors can be crucial confounders and moderators of adverse effects of PPD. These include maternal attachment style and state of mind regarding attachment (Flykt, Kanninen, Sinkkonen, & Punamäki, 2010; McMahon, Barnett, Kowalenko, & Tennant, 2006), comorbid personality disorders (Conroy, Marks, Schacht, Davies, & Moran, 2010; Conroy et al., 2012) as well as maternal interactive behavior and reoccurrence of depression (Grace, Evindar, & Stewart, 2003). To understand the nature of PPD and the troubling impact it may have on infant developmental pathways, a focus is called for not only on depressive symptoms but also on more persistent psychological maternal factors underlying PPD.

The effectiveness of EPDS for detection of women at risk for or suffering from PPD at a clinical level is well-documented, and across countries the EPDS has been shown to have a high sensitivity (68–95%) and high specificity (78–96%) against a clinical psychiatric diagnosis of depression (Chaudron et al., 2010; Chaudron et al., 2004; Adouard, Glangeaud-Freudenthal, & Golse, 2005; Boyce, Stubbs, & Todd, 1993; Murray & Carothers, 1990; Cox, Holden, & Sagovsky, 1987). However, little is known as to whether women scoring high on the EPDS also have underlying psychological difficulties that may interact with the assumed negative effects of PPD.

To address this question, the current study reports on the extent to which new mothers with EPDS scores above the cut-off for depression, and a non-depressed comparison group, also had high levels of personality pathology, and insecure states of mind regarding attachment. These are both maternal factors in the literature associated with an increased risk for compromising the developing relationship between mother and child (Conroy, Marks, Schacht, Davies, & Moran, 2010; Conroy et al., 2012; Hobson, Patrick, Crandell, Garcia-Perez, & Lee, 2005; for a meta-analysis of associations between adult attachment, parental responsiveness, and infant attachment, see van IJzendoorn, 1995).

Postpartum depression and maternal attachment

To our knowledge, only one study has specifically examined links between PPD and adult attachment representations as assessed by the Adult Attachment Interview (AAI: George, Kaplan, & Main, 1985) which is considered to be the gold standard for measuring adult attachment (for a

review, see Hesse, 2008). This study found that mothers diagnosed with depression in the postpartum period were more likely to be classified as having an insecure state of mind regarding attachment compared to mothers with no depressive symptoms (McMahon, Barnett, Kowalenko, & Tennant, 2006). AAI was administered 12 months postpartum, and PPD was measured at 4, 12, and 15 months postpartum. Mothers with depression at 4, 12 and/or 15 months were significantly more likely to have an insecure state of mind regarding attachment compared to never-depressed mothers, with a similar but non-significant trend for mothers who only showed symptoms of depression at 4 months. Due to sample size the authors did not conduct analysis of AAI sub categories.

Using the instrument the Attachment Style Interview (ASI: Bifulco, Moran, Ball, & Bernazzani, 2002) administered during pregnancy, Bifulco and colleagues found that insecure attachment style was significantly related to postpartum depression (Bifulco et al., 2004). The ASI evaluates characteristics of current adult attachment style regarding a person's ability to access and utilize social support, and thus differs from the AAI by not inquiring about childhood experiences.

If including studies of depression not limited to the postpartum period, it is well-documented, that an insecure state of mind with respect to attachment is associated with an elevated risk for depression. Based on meta-analysis of more than 200 studies using the AAI, Bakermans-Kranenburg and van IJzendoorn (2009) found that in depressed individuals dismissing as well as preoccupied strategies often are present as compared with non-depressed individuals. As a unique feature of the reviewed depressive samples the unresolved category was relative absent as compared to other clinical samples.

Postpartum depression and maternal personality pathology

Associations between depression and the presence of personality disorders (PD) have been found in a wide range of studies, and within adult psychiatry it is generally accepted that high levels of comorbidity between major depression and PD exist (Gulec & Hocaoglu, 2011; Vilaplana, McKenney, Riesco, Autonell, & Cervilla, 2010; Viinamaki et al., 2006; Oldham et al., 1995; Fava et al., 1996; Corruble, Ginestet, & Guelfi, 1996). Of note, associations between depression and for example, borderline personality disorder have been found to be very strong (Paris, 2007; Reichborn-Kjennerud et al., 2010).

In the case of PPD more specifically, only one study to date has focused on whether mothers suffering from a PD are more likely to experience PPD. Apter and colleagues (2012) compared 39 PPD-mothers to 70 non-depressed mothers three months postpartum and found that twice as many of the depressed mothers had PD than did non-depressed mothers (Apter, Devouche, Gratier,

Valente, & Le Nestour, 2012). Another study examined predictors of persistent PPD in a sample of 34 women and found that having a PD was a predictor of one-year PPD (Uguz, Akman, Sahingoz, Kaya, & Kucur, 2009). However, these findings have not yet been replicated, so little is known as to whether the proposed associations between PPD and PD holds for other study populations.

The current study

The primary aim of the present study was to examine whether women referred on the basis of a score within the clinical range of the EPDS two to three months postpartum would show more insecure states of mind regarding attachment and higher levels of personality pathology compared to women scoring in the non-clinical range. Based on the above reviewed literature, we expected that referred women would display (a) more insecure state of mind regarding attachment and (b) more personality disorders, and more specifically, we expected that higher scores on the EPDS would be associated with higher levels of personality pathology (i.e. more symptoms of PDs). Additionally, we explored associations between state of mind regarding attachment, personality pathology and postpartum depression.

Method

Sampling strategy

This study was embedded in a larger longitudinal research project studying early mother-infant interaction and transgenerational transmission of attachment patterns. Participants for the referred group were recruited via an EPDS-screening 8 weeks postpartum administered by a public health care nurse during routine visits at home (as part of the general social security and health care system in Denmark, all families are offered health care visits in the home at least 5 times during the first year after a new child is born). If a first time mother scored above the recommended cut-off on the EPDS, the nurse informed her about the research project. If interested, the woman would be referred to the research unit for an introduction meeting and further screening.

Sampling and flow of participants is shown in Figure 1. Of the 32 originally enrolled mothers two dropped out of the project after enrolment due to inconvenience, resulting in a final sample of 30 referred mothers. One of these mothers lived with the infant's farther at enrollment, she had completed 16 years of education, and she was 41 years old. The other was single-mother, she had completed 15 years of education, and she was experiencing severe social adversities. Beside single-

parent status, none of these two mothers differed from referred or non-clinical mothers with respect to any other background variables.

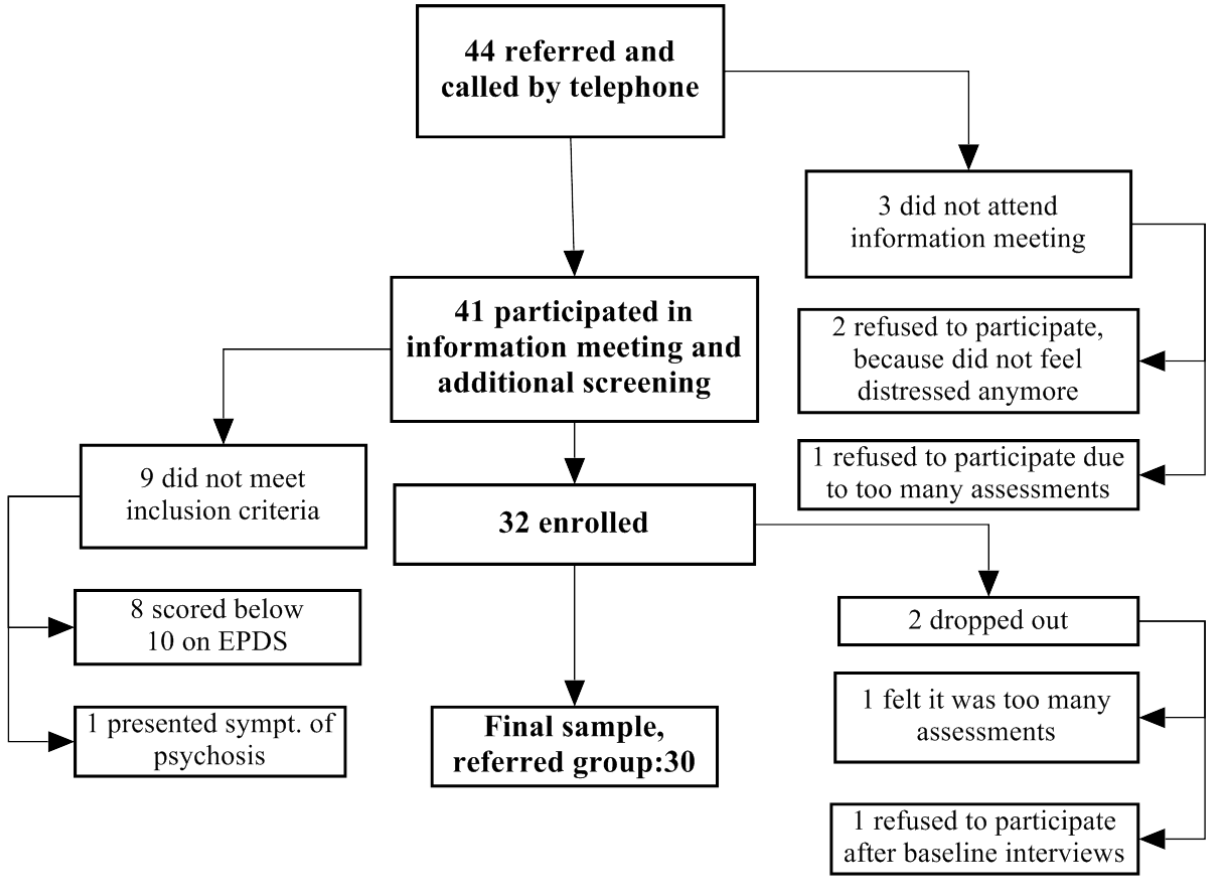

Figure 1. Flow of participants, referred group.

Participants for the comparison group were drawn from a sample of non-clinical women recruited during pregnancy with the aim of studying the emerging mother-infant relationship during the first year after birth (non-clinical group). At baseline (in the third trimester) first, all women in this group were assessed with the clinical interview Present State Examination (PSE: Wing, Cooper, & Sartorius, 1974) to ensure that the mother did not present Axis-I psychopathology at enrollment. Second, they were assessed for attachment status and personality pathology (see below). Finally, they were screened with the EPDS 6-9 weeks postpartum to identify mothers who developed depressive symptoms postpartum. Figure 2 shows the flow of participants for the non-clinical group.

Inclusion criteria for both groups were: First-time mother, singleton, and somatically well. For the referred group the primary inclusion criteria was a score within the clinical range of EPDS

at referral. Exclusion criteria for both groups were: Drug or alcohol abuse, signs of psychotic psychopathology, premature birth, child diagnosed with any major physical or mental disabilities after birth, mother developed any severe neurological or somatic illnesses within the first year postpartum, mother being a student at the department where the research was conducted, and mother living too far away from the research unit (based on the assumption that this could increase the risk for drop-out). For the non-clinical group, mothers would not be included, if all interviews were not conducted before she gave birth, or if the mother was set to give birth a time, which implied that baseline assessments should be undertaken outside the period where intake was planned. Participants in the non-clinical group were excluded from the present study if the mother scored within the clinical range of the EPDS 6-8 weeks postpartum (n=5). 55 dyads met inclusion criteria for the non-clinical group in the present study.

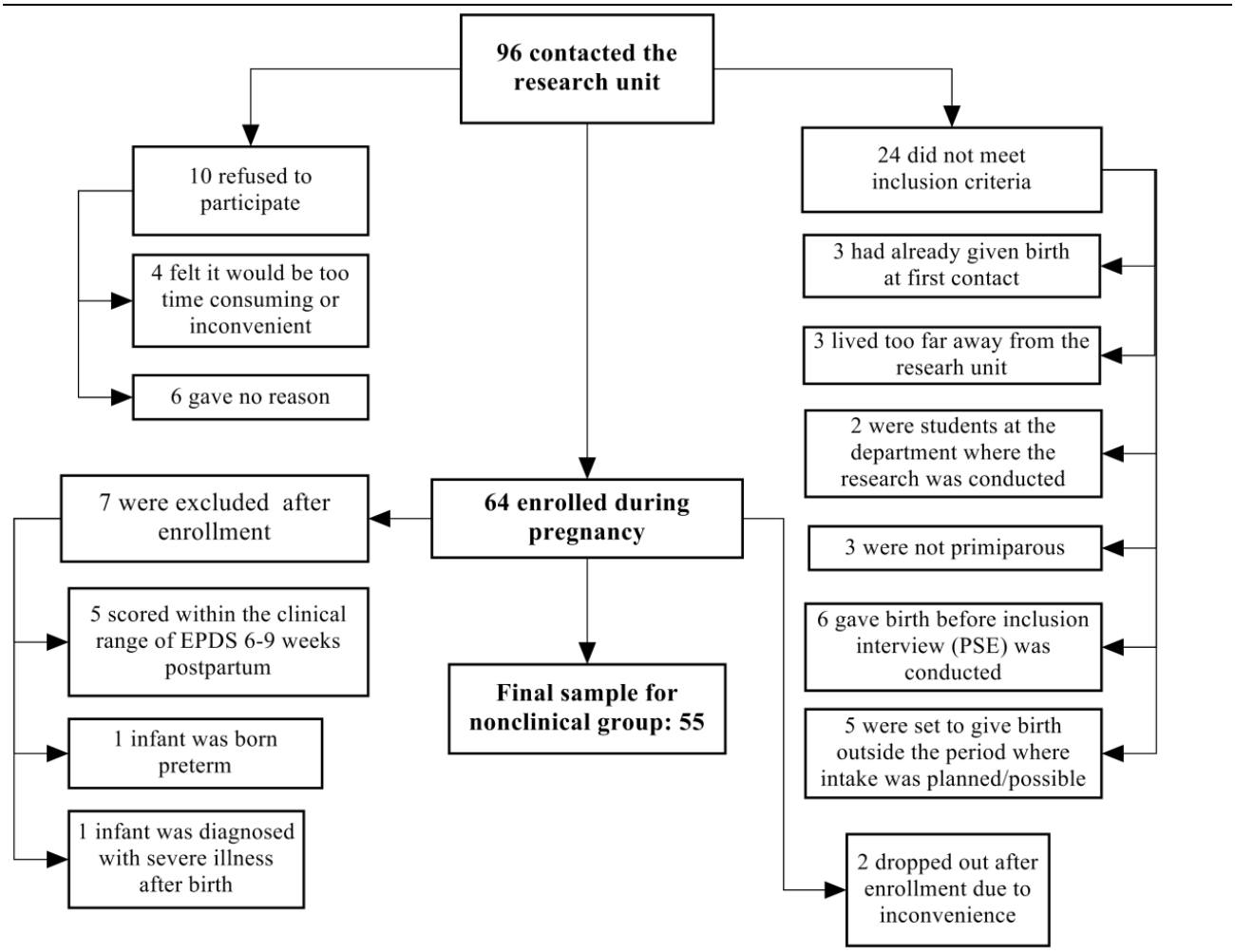

Figure 2. Flow of participants, non-clinical group.

Sample

Sample characteristics are shown in Table 1. As a result of sampling strategy, referred mothers scored significantly higher on the EPDS. Of the 30 referred mothers 28 (93.3%) fulfilled criteria for clinical depression according Diagnostic and Statistical Manual of Mental Disorders (DSM-IV: American Psychiatric Association, 2000). Of these 28 mothers, 26 (80%) fulfilled criteria for major depression. Besides differences in depression measures, there were no significant differences between the referred and non-clinical groups in terms of standard demographic considerations, such as education, age, nationality, gender of child, single-parent status, child's birth weight, and gestational age.

As shown in Table 1, mothers in both groups were generally highly educated, with 33.3% (referred) and 49.1 % (non-clinical) having completed an education on ISCED-level 7 or 8, which in the Danish system means having a university degree on Master's or PhD level. In comparison, in the period from year 2010 to 2013, 6-7% of the Danish adult female population had completed an education on ISCED-level 7 or 8 (Statistics Denmark, a). Furthermore, 50% of the referred mothers and 34.5% of the non-clinical mothers had completed an education on ISCED-level 5 or 6, which equals a Bachelor's degree in the Danish system (as compared with 19% of the general Danish female population). Only one mother in each group was single/not living with the child's farther. In comparison, in the period 2010 to 2013, one-child families with a single woman as caregiver, accounted for 25% of all families in Denmark (Statistics Denmark, b*)*. Maternal mean age was 30.5 years in both groups, with the youngest being 22 and the oldest being 43 years old at the time of the child's birth. The mean age for the general Danish population of primiparous women in the period from year 2000 to 2012, was between 28 and 29 years (Statistics Denmark, c). Finally, all infants were born with normal birth weight, and no infant was born premature, the latter being a result of the sampling strategy. Thus, table 1 confirms the low-risk nature of the participants in the current study.

Table 1

Maternal and infant characteristics

Variables	Referred group (*n*= 30)	Non-clinical group (*n*=55)	*p*
Maternal age at delivery, years, *M* (SD)	30.47 (4.075)	30.45 (4.140)	.99
Maternal age range	22-39	23-43	
Parents not living together, *n* (%)	1 (3.3)	1 (1.8)	.58
Maternal years of education, *n* (%)			.51
9-12 (ISCED[1] level 1-3)	3 (10.0)	5 (9.1)	
14 (ISCED level 4)	2 (6.7)	4 (7.3)	
15 (ISCED level 5 and 6)	15 (50.0)	19 (34.5)	
17 or more (ISCED level 7 and 8)	10 (33.3)	27 (49.1)	
Maternal occupational status, *n* (%)			.27
Unemployed	5 (16.7)	4 (7.3)	
Maternal nationality, *n* (%)			.69
Danish	27 (93.3)	53 (94.5)	
Neighboring European countries	3 (6.7)	3 (5.5)	
Infant gender, *n* (%)			.65
Female	14 (46.7)	29 (52.7)	
EPDS-score[1,]	15.8 (4.0)	4.1 (2.48)	.000
DSM-IV depression diagnosis, n (%)			.000
None or minimal depression	2 (6.6)	55 (100)	
Minor depression	2(6.6)	-	
Major depression	26(86.7)	-	
Gestational age at birth, weeks, *M* (SD)	40.1 (1.3)	40.6 (1.2)	.16
Gestational age at birth, range	38.3 - 42.1	38.1-42.4	
Infant Birth weight, g., *M* (SD)	3447.26 (437)	3579.60 (535)	
Birth weight, range, g.	2730 – 4600	2620 – 4900	.24

Note: ISCED= International Standard Classification of Education by UNESCO. DSM-IV = Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR: American Psychiatric Association, 2000). [1]EPDS was measured at 8-10 weeks postpartum for referred mothers, and at 6-8 weeks postpartum for non-clinical mothers.

Measures

Maternal depression

We used the Danish version of the EPDS which has been translated into Danish and then back-translated (Nielsen, Videbech, Hedegaard, Dalby, & Secher, 2000). The EPDS is a 10-item self-rated questionnaire intended to assess the existence and severity of depression symptoms in

postpartum women (range: 0-30). Scores in the range of 0-9 are considered as indicating the presence of symptoms of distress that may be short-lived. Scores from 10 to 12 are considered to indicate probable depression and further assessment is recommended. Scores equal to or above 13 are considered to indicate the presence of depression (Murray & Carothers, 1990; Cox et al., 1987). In the present study a score equal to or above 10 at both referral and introductory interview was used as the cut-off for inclusion in the referred group. Likewise, a score of 10 was used as cut-off in the non-clinical-group to ensure the exclusion of potential postpartum depressed women.

The standardized psychiatric interview Present State Examination (PSE) (Wing, Cooper, & Sartorius, 1974) which is a structured interview for clinicians widely used for diagnosing psychopathology was administered after intake in both groups. In the referred group PSE was used to confirm clinical diagnosis of depression. In the non-clinical group, it was administered to assess symptoms of Axis-I psychopathology at enrollment, prenatally.

Maternal state of mind regarding attachment

To assess maternal state of mind regarding attachment, the Adult Attachment Interview (AAI: George et al., 1985) together with the standard approach to rating and classifying the interview (Hesse, 2008; Main, Goldwyn & Hesse, 2003) was administered in both groups as part of the baseline assessment. In the non-clinical group, AAI was administered in the third trimester after enrollment, on a separate occasion. In the referred group, AAI was administered after referral and enrollment at a separate occasion, scheduled 9 to 12 weeks postpartum.

As mentioned, the AAI is considered to be the gold-standard measure of adult attachment representations, and its power to predict parenting and infant-mother attachment has been shown in numerous of studies (for a review, see Hesse, 2008) including a classic meta-analytic review paper by van IJzendoorn (1995). The interview is semi-structured and consists of 18 questions probing to elicit specific semantic and episodic childhood memories of experiences with attachment figures as well as evaluations of the ways in which these experiences influence current functioning. Coding of the AAI results in one of three main adult attachment classifications: Secure-Autonomous (F), Insecure-Dismissing (Ds), and Insecure-Preoccupied (E). Individuals who produce AAIs judged in the F classification value attachment experiences and are able to freely evaluate the impact of these experiences on their later functioning. Individuals whose AAIs are classified Ds are actively idealizing, derogating, or restricted in emotion when talking about their attachment experiences and the impact these have on them. The E classification is assigned to interviews where the informant appears currently pre-occupied with earlier attachment experiences. Preoccupation is expressed in

either a passive dependent form, or an angry involving form. In the passive case, the interviewer feels a pressure or implicit request to step in and finish the speaker's sentences. In the angry case, the interviewer feels a pressure to agree with how awful one or both parents were in the speaker's experience. A fourth consideration concerns trauma or loss that may be spoken about in an unresolved manner (U). A U-score is assigned whenever significant loss or trauma is identified in an interview. The coder looks for evidence of lapses in the monitoring of speech or reason, excessive attention to detail, absorption, and guilt, or an unsuccessful denial of abuse. When a score of 6 or more on the 9-point U (unresolved mourning) scale is assigned, the interview is classified as U. Each U interview is also classified according to the best-fitting Ds, E or F assignment. In the present study no interview was judged cannot classify (CC) classification group (Hesse, 2008).

Two raters certified as reliable coders by Main and Hesse coded all AAI transcripts. These raters had no previous knowledge of the research project, and were blind to group status and PD status. Inter-coder agreement was calculated on a randomly selected subset of 20 transcripts that was coded by both coders. For three-way classification, inter-coder agreement was 90% ($\kappa = 0.81$), and for four-way classification, inter-coder agreement was 85% ($\kappa = .73$).

Maternal personality disorders

SCID-II (Gibbon, Spitzer, & First, 1997) was administered in both groups to assess symptoms of personality pathology. In the non-clinical group, SCID-II was administered in the third trimester after enrollment, on a separate occasion. In the referred group, SCID-II was administered after referral and enrollment at a separate occasion, scheduled 9 to 12 weeks postpartum.

SCID-II is a semi-structured diagnostic interview for assessing the 10 DSM-IV personality disorders as well as depressive personality disorder, passive-aggressive personality disorder, and personality disorder not otherwise specified (PDNOS). The interview is based on a personality questionnaire consisting of 119 items each representing potential indicators of a specific PD. The interviewer inquires about items answered "yes" to identify falls positives. For example, many individuals will circle "yes" on the question "do you like to be the center of attention?" without meeting the criterion within histrionic PD "Is uncomfortable in situations in which he or she is not the center of attention". Each item is rated as 1,2 or 3, where 3 indicates that the symptom described in the criterion is present on a clinical level, being pathological, persistent, and pervasive; 2 indicates that the criterion is met on a sub-clinical level, and 1 indicates that the criterion is clearly not met. Following, Verheul, Bartak, & Widiger (2007), PDNOS was diagnosed in the present study when a mother did not fulfill diagnostic criteria for any specific PD, but met 5 or more criteria

(i.e. had 5 or more items rated as 3) across the specific PDs, causing significant impairment in functioning.

SCID-II can be used to make a PD-diagnosis either dimensionally (by noting the number of PD criteria met for each PD-diagnosis) or categorically (present or absent). We used both the categorical and dimensional approach, thus noting frequencies of PDs (where the full PD diagnostic criteria were met) as well as frequencies of criteria within each PD (were a woman presented symptoms of a PD on a clinical level, but not necessarily met full diagnostic criteria for a PD). This is in accordance to the view that cumulative scores of criteria for PD represent the data better than categorical scores alone (Hersoug, Monsen, Havik, & Høglend, 2002).

A binary variable "one or more PD" was created as one of the primary outcome variables. Additionally, in the present study a score for the total number of symptoms of PD was used as a measure of clinically significant psychological distress or impairment which is not better accounted for as a manifestation or a consequence of another mental disorder.

All interviews were sound recorded and administered by clinical psychologists trained in SCID-II. For calculation of inter-rater reliability a randomly selected subset of 28 interviews (9 referred and 19 non-clinical mothers) were rated by a second psychologist trained in SCID-II with no previous knowledge of the mothers. For the presence of any PD (categorically) inter-coder agreement was 95% ($\kappa = .90$).) Intraclass correlation coefficient (ICC) was used to test inter-coder agreement regarding symptoms present across PDs (dimensionally), i.e. numbers of items rated as 3. ICC was .96 indicating a high level of agreement.

Statistical analyses

All analyses were performed using SPSS version 20. Analyses were first conducted to determine whether any significant differences between the referred and non-clinical group existed in background variables using independent samples T-test, Chi-square and Fisher's Exact test where appropriate. No significant differences in background variables between referred and non-clinical mothers were found. To control for potential confounding effects we examined associations between background variables (see table 1), and the outcome variables (AAI classification and 'one or more PD') using logistic regression analysis and Chi-square tests. Because only one mother in each group was a single parent we did not conduct analysis for the background variable 'parents not living together', considering that this would have no statistical relevance. No significant associations were found, and therefore these variables were not included in the main analyses.

To compare the two groups with regard to AAI-classification, specific PDs, and symptoms of PD we used chi-square tests with Cramer's *V* or Fisher's exact test and odds ratios with 95% confidence intervals for 2x2 tables. In the case of continuous data we analyzed data using Pearson product-moment correlation coefficient, and independent samples t-tests with Cohen's *d* as index of effect size. To explore the relationship between PD, AAI-responses and postpartum depression, chi-square tests, multiple regression analysis and Analyses of Variance (ANOVA) were conducted, using EPDS-score as the dependent variable.

Results

Maternal state of mind regarding attachment

To evaluate the hypothesis that referred mothers would show more insecure state of mind regarding attachment we compared the groups two-ways (i.e. secure-insecure) and four-ways (i.e. D, Ds, E, U). Referred mothers were more often classified as insecure (40%) compared to non-clinical mothers (34.5%), although this difference was not statistically significant ($x^2(1) = 0.25$, $p = .64$). However, when analyzed four-ways significant differences between the groups were found (Fisher's exact test: $p = .029$; Cramer's V= 0.33). Distributions of AAI classifications are shown in table 2.

Table 2 suggests that the referred group presented with significantly higher levels of a preoccupied insecure state of mind than the non-clinical group. Further analysis (E versus not-E) showed that referred mothers were more likely to be preoccupied than non-clinical mothers, x^2 (1) =7.96, $p = .008$. Based on the odds ratio, the odds of being preoccupied for referred mothers were 8.07 times higher than for non-clinical mothers (95% CI = 1.56 to 41.83, $p = .01$). Subsequent analysis using independent samples T-test revealed differences between the groups regarding the subscale "Passivity or Vagueness in Discourse" (central for assigning the passive E classification). Referred mothers had significantly higher scores (M=2.75, SD=2.07) than non-clinical mothers (M=1.73, SD = 1.28), (t(83) = 2.71, 95% CI -1.73 to -0.29, $p = .006$) representing a medium-sized effect (Cohen's d =0.59). No significant differences were found for any of the other AAI subscales.

Table 2

Summary of maternal attachment AAI classifications (4-way)

	Referred group (*n*=30)			Non-clinical group (*n*=55)		
AAI classification	%	Observed count	Expected count	%	Observed count	Expected count
Secure (F)	60.0	18	19.1	65.5	36	34.9
Dismissing (Ds)	16.7	5	7.1	27.3	15	12.9
Preoccupied (E)	23.3	7	3.2	3.6	2	5.8
Unresolved (U)	0	0	0.7	3.6	2	1.3

Note: AAI = Adult Attachment Interview

Maternal personality disorders

To examine whether referred mothers would display higher levels of personality pathology we first compared the groups with regard to fulfilling diagnostic criteria for PD. Referred mothers were more likely to have one or more PD (i.e. fulfilling diagnostic criteria for PD) than non-clinical mothers, with 53.3 % (n = 16) of referred mothers versus none (n = 55) of non-clinical mothers fulfilling diagnostic criteria for one or more PD (X^2 (1) = 36.14, $p < .001$). Thirteen of the referred mothers fulfilled diagnostic criteria for one PD, and three referred mothers fulfilled diagnostic criteria for two or more PDs. Among referred mothers the following PDs were represented: Paranoid (n = 2), Avoidant (n = 2), Obsessive-Compulsive (n = 1), Depressive (n = 3); PDNOS (n = 13).

Furthermore, we compared groups with respect to distributions of symptoms of PD within each the three DSM-V axis II clusters respectively. As shown in Table 3, both referred and non-clinical mothers presented symptoms of PD and that referred mothers presented with significantly more symptoms of PD within all three clusters of DSM-IV axis II, compared to non-clinical mothers. Symptoms were most frequently observed within cluster C in both groups.

Table 3.
Number of SCID-II criteria met within cluster A, B, and C in referred and non-clinical mothers

	Referred group (*n*=30)		Non-clinical group (*n*=55)				
	M	*SD*	*M*	*SD*	p-value	95% CI	Cohen's *d*
Cluster A[1]	0.67	1.6	0.02	0.1	0.03	[-1.2 ; 0.1]	0.91
Cluster B[2]	0.77	1.5	0.07	0.3	0.02	[-1.3 ; -0.1]	0.94
Cluster C[3]	4.7	3.7	0.22	0.6	0.000	[-5.9 ; -3.1]	2.07

Note: SCID-II = Structured Clinical Interview for DSM-IV Axis II.
Cluster A = Paranoid, Schizoid, and Schizoid personality disorder.
Cluster B = Antisocial, Borderline, Histrionic, and Narcissistic personality disorder.
Cluster C = Avoidant, Dependent, Obsessive-Compulsive, Depressive, and Passive-aggressive personality disorder.

Finally, a Pearson product-moment correlation coefficient was computed to assess the relationship between scores on the EPDS and total number of SCID-II criteria met across all PDs (i.e. symptoms of PD without necessarily fulfilling criteria for any PD). There was a positive correlation between the two variables, r = .63, n = 85, p = .000, suggesting high levels of co-morbidity between postpartum depressive symptoms and symptoms of PD.

Associations between state of mind regarding attachment, PD and PPD

We then explored associations between state of mind regarding attachment, personality pathology, and postpartum depression. Chi-square tests and ANOVAs showed no significant associations between PD (diagnosis and symptoms) or and AAI (secure/insecure), AAI (four-way), or AAI (preoccupied/non-preoccupied).

Multiple linear regression analysis using PD and AAI-classification as determinants and EPDS-score as an outcome was then conducted. Based on our finding that referred mothers were more likely to be classified as preoccupied than non-clinical mothers, we used AAI-classification as "not-preoccupied vs. preoccupied" together with PD as "no PD vs. one or more PD". We found that both preoccupied AAI classification (B = 6.94, SE = 1.65, p < .001) and PD-diagnosis (B = 9.71, SE = 1.30, p < .001) were related to higher scores on the EPDS, as shown in Table 4. Preoccupied AAI classification by itself accounted for 13% of the variance in EPDS-scores. When PD diagnosis was entered into the model, this accounted for an additional 36% (R^2 change F(1.82) = 55.95, p = .000). The full model was able to account for 48 % of the variance in EPDS-score, F(2,82) = 37.83, p = .000, R^2 = .48.

Table 4

Multiple regression analysis predicting symptoms of postpartum depression from AAI-responses and the presence of one of more personality disorder

	EPDS-score			
Predictor	*B*	*SE B*	*β*	R^2 Change
Step 1				.13**
Constant	0.14	2.44		
Preoccupied vs non-preoccupied	7.32	2.13	.35**	-
Step 2				.36***
Constant	-1.28	1.90		
Preoccupied vs non-preoccupied	6.94	1.65	.34***	
One or more PD	9.71	1.30	60***	

Note: Total adjusted R^2 = .47. * p < .05. ** p < .01 *** p < .001.

EPDS= Edinburgh Postnatal Depression Scale. PD = Personality Disorder.

Finally, to disentangle effects of the three non-preoccupied AAI-classifications (i.e. Secure, Dismissing, and Unresolved), we performed additional ANOVA, using 'AAI-four way' as the independent variable. Results showed significant differences in EPDS-scores across AAI-classifications (F(1,81) = 4.156; p=.009.). Figure 3 shows that this overall difference was due to high EPDS-scores in mothers with preoccupied classification. Preoccupied mothers scored significantly higher on the EPDS in comparison with each of the three other AAI-classifications. There were no differences between any of the other three classifications.

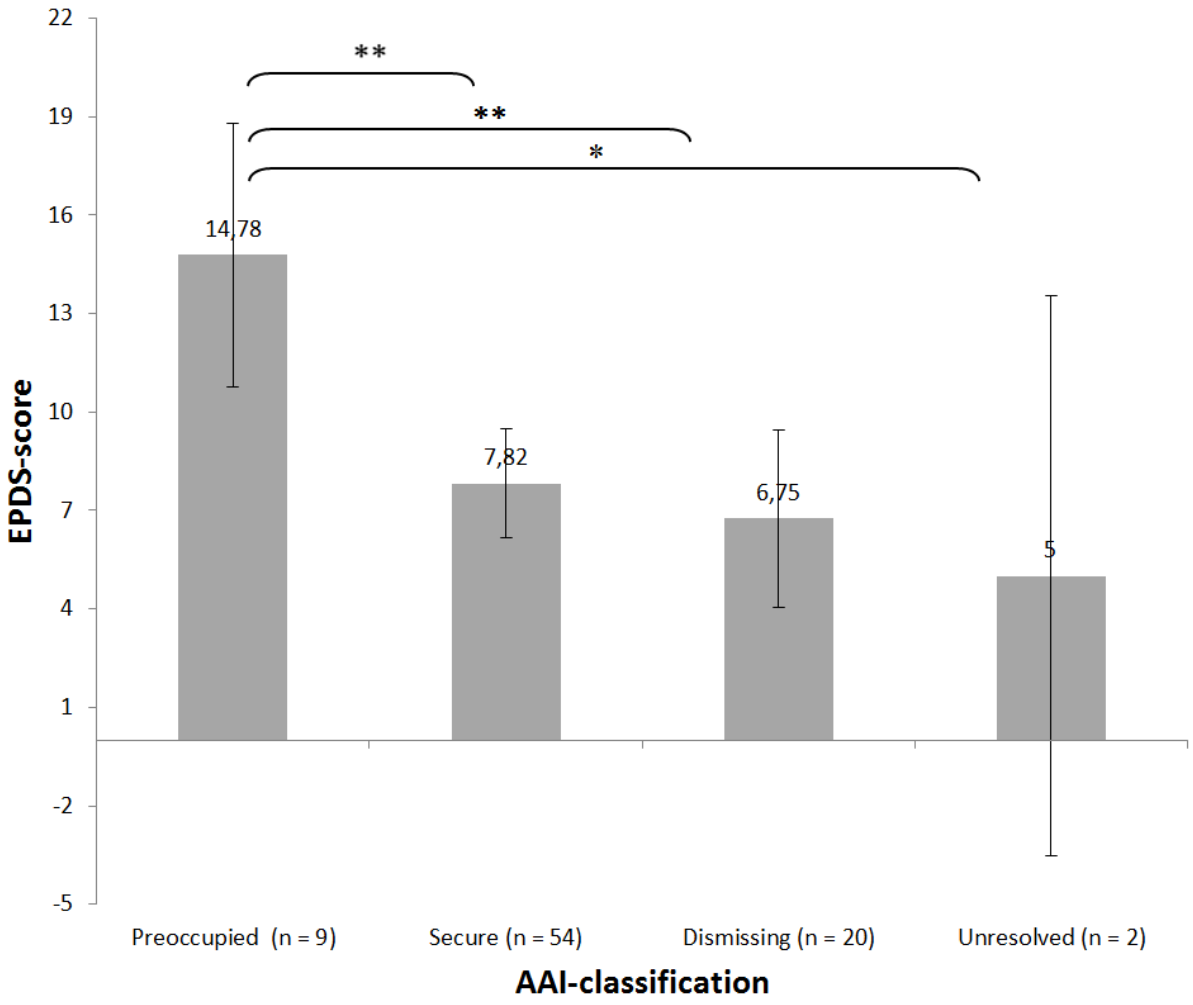

Figure 3. EPDS mean scores in the four AAI-classifications.

Note: EPDS = Edinburgh Postnatal Depression Scale. Error bars: 95 % CI. * p < .05. ** p < .01.

Discussion

In this study we addressed the question whether mothers scoring in the clinical range on the Edinburgh Postpartum Depression Scale are more likely have more insecure attachment classifications and more symptoms of personality disorders as compared with mothers who scored in the non-clinical range. Furthermore, we explored whether attachment classification and personality pathology were related and how these two factors were associated with postpartum depression.

We examined these questions within a low-risk Danish sample. Both referred and non-clinical mothers were highly educated women, compared with Danish national levels, they had low levels of unemployment, and with infants born at term with normal birth weights. Furthermore, only one mother in each group was single. Despite the low-risk nature of the sample, 93.3 % of referred mothers fulfilled diagnostic criteria for clinical depression; if only including major depression, the number was reduced to 80%. This sampling strategy prevents generalization to low-SES groups living with current (and past) social adversities; at the same time the homogenous sample permits a greater opportunity to isolate the variables under study and their links with one another.

Maternal state of mind regarding attachment

Our first hypothesis that referred mothers would show more insecure states of mind regarding attachment was supported in respect of the significantly elevated levels of preoccupied states of mind in the referred group as compared to non-clinical mothers. Preoccupied states of mind are typically linked to one of two dimensions scored regarding the language used by speakers as they are asked to describe and evaluate their primary attachment experiences, namely whether this is done in an involving angry way, or a passive vague way (Hesse, 2008). In the current study, it was passive speech (not anger) that typified mothers with depression. High scores on the "Passivity or Vagueness in Discourse" are assigned, for example when the speaker seems unable to focus on a topic, is unable to find words, or speak as a very young child. The speaker may use vague expressions or even nonsense words. On the face of it, depression and Passivity or Vagueness in Discourse make for a problematic combination, as so much of the new mother's circumstance demands prompt and decisive (caring) action. The demands of a young infant may cause added distress and feelings of helplessness for these mothers and thereby increasing the risk for developing depression.

These results concur with findings reported by Murray and colleagues (Murray, Halligan, Adams, Patterson, & Goodyer, 2006). In their low-risksample, the Dismissing classification was no more common among PPD mothers than among non-depressed mothers. However, significantly more (40.8%) of the PPD mothers were classified as preoccupied than the control mothers (7.9%). Furthermore, our findings may be interpreted to be in line with the results of Bifulco et al (2004) who used the Attachment Styles Interview (ASI), asking primarily about couple relationships, to measure adult attachment during pregnancy. The ASI provides a characterization of attachment within the categories secure, enmeshed, fearful, angry-dismissive or withdrawn (Bifulco et al., 2002). In this study an anxious attachment style (enmeshed or fearful) was significantly related to postnatal depression. Neither angry–dismissive nor withdrawn styles were related to postnatal depression. Considering that anxious attachment conceptually is close to the preoccupied AAI-classification, it may be argued that our findings also concurs with the results of Bifulco and colleagues (2004). Taken together this may suggest that in particular new mothers with a Preoccupied state of mind regarding attachment are at greater risk for developing postpartum depressive symptoms in comparison with mothers whose AAIs are classified as Secure or Dismissing.

When interpreting our results, it is important to take the AAI-distribution in the non-clinical group into consideration. The distributions of AAI-responses differed in several aspects from normative samples of non-clinical European populations in which four-way distribution of 25% Ds, 52% F, 11% E, 12% U/CC has been found (for a metaanalysis, see Bakermans-Kranenburg & van IJzendoorn, 2009). First, we found a higher proportion (65.5%) of AAIs assigned to the Secure category as well as a lower proportion of Unresolved (3.6%). This can be interpreted as a reflection of this sample being a low-risk sample. Furthermore, it is possible that the method of recruitment for the non-clinical group implied a selection bias. Women who volunteer for a time-consuming research project that involves sharing personal information about themselves and their parenting may to a larger extend be classified as Secure, and show less signs of unresolved loss and trauma than women who do not wish to volunteer for such a research project. Second, a distribution of 27.3 % Dismissing and 3.6 % Preoccupied was also not to be expected when compared to normative non-clinical samples. Considering the high proportion (65.5%) of secure AAIs, a frequency of Dismissing of 27.3 % (versus 25% in normative samples) is unexpected. However, a recent study including 91 Danish non-clinical physically healthy first-time mother's AAI responses (AAI administered during pregnancy) reported a four-way distribution with 37% assigned to the dismissing category (Stenstrup, 2013). This is the only other study examining distributions of AAI-

classifications in Danish or Scandinavian non-clinical samples. Therefore, it remains uncertain whether the AAI distributions in our non-clinical group are representative of the Danish population, and a reflection of cross cultural differences in AAI distributions, with a tendency towards a higher proportion of Dismissing versus Preoccupied in the insecure categories. If that is the case, that Preoccupied responses to the AAI are atypically low in Denmark, it would help explain why the Preoccupied state of mind was linked to PPD in our sample, as this may be a state of mind unlikely to be shared or appreciated by family members or friends. In other words, given that mothers in the two groups studied did not differ in any background variables, it may be suggested that Danish mothers whose AAIs are classified as preoccupied, and more specifically the passive subgroup, are at greater risk for PPD than are mothers whose AAIs are classified as Secure or Dismissing.

Maternal personality disorders

Our second hypothesis that referred mothers would show higher levels of personality pathology was supported. Scores on the EPDS were significantly related to number of symptoms of PDs across all PDs, suggesting high levels of co-morbidity between PPD and symptoms of PD. Referred mothers were significantly more likely to have one or more PD compared to non-clinical mothers with more than half of the referred mothers having one or more PD versus none in the non-clinical group. Mothers in the non-clinical group also presented symptoms of personality pathology (though not fulfilling diagnostic criteria for PD), however referred women presented significantly more symptoms of PD within all three clusters of DSM-V axis II, with symptoms within cluster C being most frequently observed. Becoming a mother is a major life-event that requires considerable psychological resources to adapt to sometimes very stressful circumstances, and the quality of this adaptation may have considerable impact on the new mother's own and her child's psychological health. It is very likely, that women struggling with relationship-oriented difficulties – which is at the core of personality disorders – are more vulnerable to developing depressive symptoms when faced to the challenges of establishing a close relationship to an infant compared to women not having symptoms of personality disorders.

Only one previous study (Apter et al., 2012) has examined whether there is a greater incidence of PD among a PPD-population than among a non-PPD populations. In line with our findings, in this study it was found that twice as many of PPD mothers fulfilled diagnostic criteria for PD, compared to non-depressed mothers. It is noteworthy, however, that no mother in our non-clinical group had PD, whereas Apter et al. reported a prevalence of any PD of 30% in their non-

depressed group. Yet, this substantial difference is most probably due to the fact that Apter et al.'s comparison group was recruited in a clinical setting as opposed to our non-clinical group being a low-risk, self-referred sample as discussed above. Recently, a survey across 13 countries by WHO using DSM-IV criteria estimated a prevalence rate of any PD in Western European countries of 2.4% (Huang et al., 2009). This indicates that both our non-clinical group and Apter et al.'s comparison group are most probably not representative of a normal population. Despite these unlike study populations the relative difference between groups regarding frequency of PDs is very similar. Another difference between the findings reported by Apter et al. and our results are the specific PDs observed. While Apter et al. found that PPD mothers were most likely to have PDs within cluster B, we found symptoms within cluster C to be the most frequently observed among referred mothers. However, taking the low-risk nature of the current sample into consideration, it may not seem surprising that the more severe and disabling PDs within Cluster B are not as frequently represented as in Apter et al.'s clinical sample.

Links among AAI-classification, personality disorders and postpartum depression

Finally, we addressed the question whether the mothers AAI-classification would be associated with PD, and how these factors together related to symptoms of postpartum depression. No associations between AAI-classification and personality disorders were found, regardless of whether we used a dimensional approach for measuring PD (number of PD symptoms) or a categorical approach (fulfilling diagnostic criteria for PD or not). However, results revealed that both AAI-classification (and more specifically the preoccupied classification) and PD-diagnosis were significantly associated with higher scores on the EPDS. That is, even after taking into account the well-established link between AAI insecurity and depression (Bakermans-Kranenburg & van IJzendoorn, 2009), PD accounted for a large and independent proportion of the variance in EPDS-scores. Together, AAI-classification and PD accounted for almost half of the variance in EPDS-scores. Neither of the three other AAI-classifications differed with respect to EPDS-score. Based on previous literature (see for example, Fonagy, Target, Gergely, Allen, & Bateman, 2003; Fonagy et al., 1996) one might expect that the insecure AAI-classifications, and in particular the Preoccupied and Unresolved classifications, would be associated with PD. However, this was not the case in our study. Instead, our results showed that the women who were classified as preoccupied were not the same women who had PD. Furthermore, these findings suggest that a preoccupied state of mind and having a PD may be two separate risk factors for developing postpartum depressive symptoms. Finally, when interpreting these findings, it is also worth taking

into consideration that mothers in our sample primarily presented PD symptoms within Cluster C, as discussed above. While the preoccupied AAI-classification primarily has been associated with the more severe Cluster B disorder, Borderline PD, none of the women in our sample fulfilled criteria for a Cluster B disorder.

Conclusions

Following Apter and colleagues, our findings may reflect that PPD not always is "only" a mood disorder. Previous research on risk factors for PPD has had a tendency to focus on "external" risk factors, such as poor social support and marital relationship, low SES status, and stressful life events (see for example, O'Hara, 2009). However, our findings suggest that important risk factors may also be underlying persistent psychological characteristics, such as preoccupied state of mind regarding attachment and personality pathology.

Previous findings have been inconsistent with regard to effects of PPD on parenting and infant developmental outcome. This might be due to a tendency to view PPD mothers as a homogenous group. In line with the findings of Apter et al., our findings suggest that PPD mothers are a heterogenous group. From our findings it may be concluded that this variability may include important confounding and moderating factors, such as state of mind concerning attachment and extent of co-existing symptoms of personality pathology, influencing parenting and infant developmental outcome. The more knowledge we gain about this heterogenity, the more precise we might be able to understand effects of maternal depression on infant developmental outcomes. This issue should be addressed in future research when examining effects of PPD on the emerging relation between mother and infant as well as on infant developmental pathways.

Another conclusion that may be draw from this study is that, besides the importance of early screening for symptoms of PPD, these findings underline the importance of investment in interview-based measures. Screening instruments such as the EPDS are not sufficient in detecting which PPD-mothers are in need of psychological treatment and those who only suffer from transient depressive symptoms not having a noteworthy impact on parenting.

Limitations

A limitation in the current study is the relatively small sample size. Furthermore, as already discussed, the method of recruitment of the non-clinical group is a weakness in the sense that being self-referred might inherit a selection bias in the direction of very well functioned women being over-represented, thereby overestimating the differences found. However, as a clinical group, the

referred women in our study were also well-functioning women with low levels of unemployment and high levels of education. In comparison to Bakermans-Kranenburg and van IJzendoorn (2009)'s meta-analysis in wich the secure category was represented by 31% in depressed samples, a frequency of 60% found in our referred group indeed seems very high. This may also reflect that even though all but two of the women in our referred group fulfilled criteria for clinical depression, as a clinical group they may be seen as a low-risk group. Furthermore, it may be argued that the self-referred selection-bias existing in the non-clinical group holds for our referred group as well. Women who have symptoms of depression in the postpartum period and who volunteer for a longitudinal research project may also represent a more well-resourced sub-group of PPD-populations. Hence, it may be argued that the two groups are comparable, and that the differences found are representable for well-resourced PPD-mothers.

Another concern could be the validity of the comorbid diagnoses of PPD and PD. It could be argued that PD is maybe over-diagnosed when assessed during a depressive episode. Yet, it has been found that PD is remarkably stable over time and that PD status is not effected by depression status (Morey et al., 2010). Furthermore, an essential aspect of the SCID-II is to ensure that the enduring pattern inquired about is not better accounted for as a manifestation or consequence of an episodic mood disorder. Similarly, it may be argued that administering the AAI during a depressive episode could influence the response, or that our groups are not comparable with respect to administering AAI prenatally (non-clinical mothers) and postnatal (referred). However, the AAI has been subjected to a series of psychometric tests of stability (Hesse, 2008), and AAI-classifications have been reported to be strikingly stable. For example, Benoit and Parker (1994) found 90% three way stability between a prebirth interview and interviews conducted 11 months after birth.

Finally, a limitation of the study is that we did not have information available regarding maternal antenatal history of depression, and therefore ongoing depressive disorders could not be disentangled from more transient episodes of postpartum depression. This issued should be addressed in future research.

Despite these limitations, this study stresses the view that to understand the nature of PPD and the troubling impact it may have on infant development, it is vital not only to focus on the acute depressive symptoms, but also on more persistent psychological factors potentially underlying PPD.

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Appendix III: PhD Paper 2

Under review

Effects of maternal postpartum depression in a well-resourced sample: early concurrent and longitudinal effects on infant cognitive, language, and motor development.

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Running head:
Early concurrent and long-term effects of postpartum depression

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Abstract

This study examined early concurrent and long-term effects of maternal postpartum depression on infant cognitive, language, and motor development in infants of clinically depressed mothers compared with infants of non-depressed mothers. The study is the first to specifically examine concurrent effects of maternal depression on infant development in the postpartum period at the time when postpartum symptoms are most present. Participants were 83 mothers and their full-term healthy born children from the urban region of Copenhagen, Denmark. Of this group, 28 mothers were diagnosed with postnatal depression. Postpartum depressive symptoms were measured with Edinburgh Postnatal Depression Scale and diagnoses were validated in a clinical interview. Co-morbid maternal psychopathology was assessed in the clinical interview Structured Clinical Interview for DSM-IV axis II personality disorders. Cognitive, language, and motor development was assessed with the Bayley Scales of Infant and Toddler Development third edition, when infants were 4 and 13 months of age. We found that maternal postpartum depression was associated with poorer cognitive development at infant age four months, the effect size being large and with similar effects for boys and girls. At 13 months of age infants of mothers who had been suffering from depression three to four months postpartum did not differ from infants of non-clinical mothers. However, regardless of depression boys scored lower on the language scale at 13 months of age. Results are discussed in terms of risk- and protective factors impacting on infant development diferently at different ages. Furthermore, our results may indicate that maternal depression can have an acute, concurrent effect on infant cognitive development as early as at four months postpartum; at the same time, in the lack of other risk factors, this effect may not be enduring.

Introduction

Postpartum depression (PPD) is a common disorder among childbearing women. Across cultures as many as 7.1% of women have been reported to experience a major depressive episode in the first three months postpartum, and if including minor depression, this prevalence rate increases to 19.2% (Gavin et al., 2005). Given the high prevalence it is essential to understand how PPD might impact on parenting and subsequent infant developmental outcomes. The current study reports on early concurrent and long-term effects of PPD on global indices of infant development, i.e. cognitive, language, and motor development.

It is well documented that PPD has the potential to disrupt aspects of caregiving known to be critical for healthy child development. A meta-analytic review of 46 observational studies showed that currently depressed mothers show more irritable, critical, and coercive elements in their

parenting compared to non-depressed mothers (Lovejoy, Graczyk, O'Hare, & Neuman, 2000). A more recent review concluded that even more fundamental functions of parenting can be compromised by PPD (Field, 2010). These include feeding practices, sleep routines, and well-child visits and vaccinations. Likewise, numerous of studies have documented that concurrent PPD can have negative consequences for the dyadic exchanges and affect regulation in early mother-infant interactions (Beebe et al., 2008; Hernandez-Reif, Field, Diego, Vera, & Pickens, 2006; Feldman et al., 2009; Reck et al., 2004; Righetti-Veltema, Conne-Perreard, Bousquet, & Manzano, 2002; Tronick & Reck, 2009), which are considered to be important factors in infant's development.

However, research findings have been inconsistent regarding long-term effects of PPD on child developmental outcomes with some studies finding adverse effects, some finding no effects, and some finding effects only under certain circumstances. One study found negative effects of PPD on child language development at age 5 (Brennan et al., 2000), another found a significant association between brief PPD at 3 months and the child's Full Scale IQ at age 4 and 11 years (Hay et al., 2001). More recently, a study using multilevel modeling suggested that infants of depressed mothers had a stable lower cognitive scores when tested at 6, 12 and 18 months of age compared with infants on non-depressed mothers (Azak, 2012). Other studies have reported no association between PPD and infant cognitive, motor and language development at 18 months (Piteo, Yelland, & Makrides, 2012), cognitive development at 12 month (Keim et al., 2011), and cognitive development at 20 months, 5 years, and 7 years of age (Kurstjens & Wolke, 2001). Murray and colleagues assessed object permanence in nine month old infants of mothers with PPD and found a significant adverse effect when compared with infants of non-depressed mothers, but at 18 months no overall effect on cognitive development was found (Murray, 1992; Murray, Hipwell, & Hooper, 1996; Murray et al., 1996). However, boys of PPD mothers displayed poorer cognitive development at 18 months compared with girls of PPD mothers, suggesting that gender may be a moderator of effects of PPD. Others have found similar effects of gender, with boys of PPD mothers showing more difficulties in affect regulation during early interactions than girls of PPD mothers (Weinberg, Olson, Beeghly, & Tronick, 2006), but some studies found did not find gender to be a moderator of effects of PPD (e.g. Cornish et al., 2005).

The most consistent associations between maternal depression and negative effects on children's development have been found in the case of chronic or recurrent depression lasting through the first year postpartum (Appelbaum et al., 1999; Brennan et al., 2000; Cogill, Caplan, Alexandra, Robson, & Kumar, 1986; Cornish et al., 2005; Hay et al., 2001). In a recent study both maternal depression and infant cognitive development were assessed five times during the first two

years after birth (Sutter-Dallay et al., 2011). This study showed that depressive symptoms six weeks postpartum were significantly associated with infant cognitive development at 24 months, with higher depression scores predicting lower cognitive scores in children. However, when taking into account maternal concurrent depression over the first two years postpartum, this association was no longer statistically significant. This finding may indicate that adverse effects of PPD reported in some studies, are partly explained by persistent, concurrent, or chronic depressive symptoms.

A potential reason for the lack of consensus among studies may be related to the timing of assessment of infant development. PPD onset, for the majority of women, occurs before three months postpartum and often resolves within six months after birth (Gavin et al., 2005; Pearlstein, Howard, Salisbury, & Zlotnick, 2009; Sheeder, Kabir, & Stafford, 2009). Consequently, it might be the case that that long term effects of PPD on infant development, for a large part, have been diminished or buffered by protective factors in the infant's environment at the time when development is measured. Despite the well-studied negative effects of concurrent depressive symptoms for mother-infant interactions as described above, most research on child developmental outcomes has focused on long-term effects, typically measured at least 12 months after birth. Little is known as to whether how the concurrent exposure to maternal depressed mood impacts on infant development at the time when maternal postpartum depressive symptoms typically are most present, i.e. before 6 months postpartum (Sheeder, Kabir, & Stafford, 2009). Such studies may help explain differences in long-term outcomes. As one of the few studies that examined infant development before the first birthday, the above-mentioned study by Murray (1992) showed an effect of PPD on object permanence tasks at infant age nine months, but no overall effect on infant cognitive development at 18 months. Although Sutter-Dallay and colleagues (2011) assessed infant cognitive and psychomotor development as early as infant age three and six months, they did not examine effects of PPD on infant early development, but on only focused on outcomes at 24 months. The present study extends previous research by addressing potential early concurrent effects of PPD on infant development additionally to examining long-term effects.

It has been suggested that another possible explanation for the divergent results regarding long-term effects of PPD on infant development could be lack of controlling for key confounding and moderating factors which may interact with the assumed negative effects of PPD (Keim et al., 2011; Piteo et al., 2012). For example, factors such as maternal educational level, socioeconomic (SES) status, social adversities have consistently been found to be associated with both maternal depression and infant development; and as mentioned above, infant gender might moderate the association between maternal depression and child outcomes (Azak, 2012; Koutra et al., 2012;

Kurstjens & Wolke, 2001; Murray et al., 1996; Wu et al., 2008). Furthermore, different instruments used to assess maternal depression as well as different definitions of depression may account for some of the inconsistency. Much of the reported findings within this field rely on self-report questionnaires of depressive symptoms which are not validated by a clinical diagnosis of depression. This may lead to the inclusion of a large number of women who do not fulfill criteria for clinical depression, or whose primary diagnose is not depression (Rowe, Fisher, & Loh, 2008). (Gaynes et al., 2005). The present study depression diagnosis was validated in a diagnostic interview, as well as it includes important potential confounders and moderators when examinatining of effects of PPD on infant development.

The current study

The objective of this study was to examine early concurrent as well as long-term effects of maternal postpartum depression diagnosed three to four months after birth on infant cognitive, language and motor development. We examined this in a sample of well-resourced and highly educated mothers and their infants, thereby minimizing effects of confounding variables. Furthermore, we examined whether potential adverse effects on infant development are moderated by infant gender as earlier findings have indicated (Murray, FioriCowley, Hooper, & Cooper, 1996). We expected that infants of mothers with clinical depression three to four months postpartum (a) would have poorer developmental outcomes at 4 months of age compared with infants of non-clinical mothers; (b) that they would have poorer developmental outcomes at 13 months, and (c) that this association would be moderated by gender, with boys of mothers with depression showing greater developmental delays than girls of mothers with depression at both 4 and 13 months of age.

Method

Procedures and participants

Participants in the current study were 28 postpartum depressed mothers (PPD group) and 55 comparison mothers without psychopathology (non-clinical group). Mothers and their children were enrolled in an ongoing longitudinal research project studying early interactional processes. For a detailed description of recruitment, sampling strategy, and flow of participants, please refer to (Smith-Nielsen et al., 2014). In short, non-clinical mothers were recruited during pregnancy via advertisement on webpages. PPD-mothers were recruited two months postpartum via screening for

symptoms of depressions using Edinburgh Postpartum Depression Scale (EPDS: Cox, Holden, & Sagovsky, 1987) by a public health care nurse during routine home visits. If a first-time mother scored within the clinical range of the EPDS, she was referred to the research unit for further assessment.

Both groups were examined for co-morbid Axis I disorders and Axis-II disorders according to Diagnostic and Statistical Manual of Mental Disorders (DSM-V-TR: American Psychiatric Association, 2000) using clinical interviews (see below). All assessments were carried out at the research unit. Infant development was assessed at 4 and 13 months. PPD-mothers were offered a six-session psychotherapeutic group intervention between 4 and 13 months assessments, and 92.8% of the mothers chose to participate in group sessions. When the dyads came to the research unit at 13 months potential concurrent or recurrent maternal depressive symptoms were assessed with the EPDS. Due to changes in assessment procedures during the project period, only the last 35 enrolled non-clinical mothers were screened for depressive symptoms at 13 months.

Dyads (both groups) were eligible to participate in our study if the infant was the mother's first child, born at term, singleton, and somatically well. Exclusion criteria were drug or alcohol abuse, psychotic symptomatology, the child having any major physical or mental disabilities after birth, or the mother developing any severe neurological or somatic illnesses within the first year postpartum. Mothers were excluded from the non-clinical group if they presented Axis-I psychopathology or scored within the clinical range of the EPDS when screened for postpartum depressive symptoms 6-8 weeks postpartum.

Initially, 32 PPD mothers were enrolled. We excluded two of these mothers because they did not fulfill diagnostic criteria for depression (one with Generalized Anxiety as the primary diagnosis and the other only presented short-lived sub-clinical depressive symptoms). Three PPD mothers dropped out during the project due to inconvenience, however, all data for one of these drop-outs were collected until the child was four months old. Thus, the PPD-group comprised 28 dyads at four months and 27 dyads at 13 months assessments. Fifty-five dyads were included into the non-clinical group in the present study. Two mothers were not able to participate in 4-months assessments, but were still interested in participating at 13-months assessments. Therefore, the non-clinical sample comprises 53 dyads at 4-month and 55 dyads at 13-months assessments.

Table 1

Maternal and infant characteristics

Variables	PPD-dyads (n = 28)	Control dyads (n = 55)	P
Maternal age at delivery, years (SD)	30.32 (4.2)	30.45 (4.1)	.891
Maternal age range	22-39	23-43	
Single parent status			.622
Parents not living together, *n* (%)	1 (3.6)	1 (1.8)	
Maternal unemployment status			.433
Unemployed, *n* (%)	4 (14.3)	4 (7.3)	
Maternal years of education, *n* (%)			.409
9-12 years (ISCED level 3)	3 (10.7)	4 (7.3)	
14 years (ISCED level 4)	2 (7.1)	5 (9.1)	
15 years (ISCED level 5)	14 (50.0)	19 (34.5)	
17 years or more (ISCED level 5-6)	9 (32.1)	27 (49.1)	
Maternal country of origin, *n* (%)			.400
From neighboring European countries	3 (10.7)	3 (5.5)	
DSM-V Depression diagnosis, *n* (%)			.000
None or minimal depression	-	55 (100)	
Minor depression	2 (7.1)	-	
Major depression	26 (92.9)	-	
EPDS 6-8 weeks (SD)	15.8 (4.2)	4.1 (2.5)	.000
EPDS 13 months (SD)	7 (4.4)[a]	2.6 (3.8)[b]	.000
Score $\leq$ 10 on EPDS at 13 months, *n* (%)	6 (21.4)	3 (5.5)	.001
Infant gender, *n* (%)			.647
Female	13 (46.4)	29 (52.7)	
Gestational age at birth, weeks (SD)	40.2 (1.3)	40.6 (1.2)	.186
Gestational age at birth, range, weeks	38.3 - 42.1	38.1 - 42.4	
Infant Birth weight, g (SD)	3466.4 (450)	3583.3 (526.2)	.339
Birth weight, range, g.	2730 - 4600	2620 - 4900	

Note: ISCED = International Standard Classification of Education by UNESCO.
[a]Available for 27 PPD mothers due to one drop out, between 4 months and 13 months
[b]Available for 35 control mothers, due to changes in assessment procedures during the project period

Measures

Maternal depression and co-morbidity.

The Edinburgh Postnatal Depression Scale (EPDS) was used for screening for depressive symptoms in the postpartum period and at 13 months. The EPDS is a 10-item self-rated questionnaire intended to assess the presence and severity of depression symptoms in postpartum women (range: 0-30). It has been reported to have good validity and sensitivity against a clinical diagnosis of depression (Boyce, Stubbs, & Todd, 1993; Adouard, Glangeaud-Freudenthal, & Golse, 2005; Murray & Carothers, 1990; Cox et al., 1987). A score between 10 and 12 is considered to indicate potential postpartum depression, and further assessment is recommended (Hiscock & Wake, 2001; Murray, 1992). In the current study, a score equal to or above 10 was used as cut-off for referral by the health-care nurses as well as for the exclusion of dyads in the control group when screened for depressive symptoms 6-8 weeks postpartum.

The standardized psychiatric interview Present State Examination, (PSE: Wing, Cooper, & Sartorius, 1974) was administered by a clinical psychologist at enrollment (both groups). PSE is a structured interview for clinicians widely used for diagnosing psychopathology (but not personality disorders/Axis-II disorders). In the non-clinical group, PSE was used as part of the sampling to assess potential symptoms of Axis-I psychopathology. In the PPD-group, PSE was administered after referral in order to validate diagnosis of depression according to according to the DSM-IV-TR, as well as to rule out that the mother's heightened EPDS-score was not better accounted for by another Axis-I disorder which previously has been documented can be the case (Rowe et al., 2008). Subclinical symptoms of other Axis I disorders were noted.

After enrollment potential personality disorder was assessed in both groups by trained clinical psychologists using the Structured Clinical interview for DSM-IV axis II disorders (SCID-II: Gibbon, Spitzer, & First, 1997). SCID-II is based on a personality questionnaire consisting of 119 items, each representing potential indicators of personality disorder. The interviewer inquires to identify false positives, and to ensure that any potential symptom of personality disorder is not better accounted for by an Axis I disorder, but is still causing significant impairment in functioning.

Infant development.

Infant development was assessed by the Bayley Scales of Infant and Toddler Development, third edition, Danish version (BSID-III: Bayley, 2009; American Psychiatric Association, 2000; Bayley,

2006) when the infants were 4 and 13 months old by experienced supervised Bayley-testers. The test items assess cognitive, language and motor development (age range: 1-42 months). The cognitive scale assesses memory and problem solving, exploration and manipulation, object relatedness, and sensorimotor development. The language scale is a composite of two subscales: an expressive scale (babbling, gesturing and utterances) and a receptive communication scale (verbal comprehension and vocabulary). The motor scale also comprises two subscales: fine and gross motor scale. Raw scores for each subscale are converted into scaled scores (range 1-19, $M = 10$, $SD = 3$), and a composite score ($M = 100$, $SD = 15$) can be derived from the scaled score for cognitive development, the sum of the two language scaled scores, and the sum of the two motor scaled scores. For the present study, we used scaled scores from the five subscales to be able to disentangle differences between receptive vs. expressive communication, and fine vs. gross motor development. Because no Danish norms for the BSID-III exist, we used American norms for the scoring. All tests were filmed to enable routinely supervision of the testers.

For an experienced tester it takes around 30 minutes at 4 months and around 90 minutes at 13 months to administer the BSID, which can be exhausting for the infant. Therefore we scheduled lab-visits to fit into the infants' eating and sleeping patterns as recommended in the BSID-III manual. At 13-months assessments, in most instances, the tester decided to take a break during the test (e.g. due to fussiness), to be able to complete the assessment. All tests were completed on the same day. If the infant arrived at the lab already tired or fussy, in some instances the tester decided to reschedule the test to another day.

Statistical analysis

All analysis were performed using SPSS version 20. Descriptive statistics were calculated for demographic variables and independent samples T-test, Fisher's Exact test, and Chi-square tests were used to test for differences between groups (PPD vs non-clinical group) in these variables.

To examine differences in BSID-III scores between diagnostic groups and between boys and girls, we performed Multivariate Analysis of Variance (MANOVA) for each assessment time (infant age 4 and 13 months) with the following dependent variables: 'cognitive', 'receptive language', 'expressive language', 'fine motor' and 'gross motor'. MANOVA was preferred over multiple Analyses of Variance (ANOVAs) to minimize the risk of Type I errors. To examine whether potential effects of PPD were moderated by infant gender as previously suggested (Murray, FioriCowley, Hooper, & Cooper, 1996a) we added an interaction term between infant gender and depression status to the model. We additionally included maternal co-morbid PD and maternal

educational level in all models due to their potential confounding effects on parenting and infant developmental outcomes (Conroy, Marks, Schacht, Davies, & Moran, 2010; Koutra et al., 2012). Finally, as a sensitivity analysis additional to 13-months analysis, we also conducted MANCOVA using 13-months EPDS score as a covariate if available (27 PPD mothers and 35 non-clinical mothers) to account for potential effects of recurrent or concurrent depressive symptoms at 13 months. Effect sizes were expressed as Cohen's *'d'*, and based on Cohen's guidelines: small when $d = 0.20$; medium when $d = 0.50$; and large when $d = 0.80$ (Cohen, 1988).

Results

Descriptives

Sample characteristics are shown in Table 1. There were no significant differences between the PPD-group and the non-clinical group in basic demographic variables, such as maternal education, single-parent status, or occupational status. As a result of the sampling strategy, both groups consisted solely of infants born at term with normal birth weight. As reported previously (Smith-Nielsen et al., 2014), despite the presence of clinically significant maternal postnatal depression, this sample must be considered as representing a low-risk population. For example, only one mother in each group was a single-parent and mothers in both groups had high levels of education with 82.1 % (PPD-group) and 86.2% (non-clinical group) having completed 15 or more years of education. In Denmark, 15 years of education means having completed three years of full-time education after high school, which equals having a College or Bachelor's degree.

Most PPD mothers (92.8%, $n = 26$) fulfilled diagnostic criteria for major depression and the remaining fulfilled criteria for minor depression. Although the majority (93.3%, $n = 25$) of mothers in the PPD-group also presented sub-clinical symptoms of other Axis-I disorders, such as symptoms of anxiety, and eating disorder, none of them fulfilled criteria for a second Axis-I diagnosis. At 13 months, six women (21.4%) in the PPD group still scored within the clinical range of the EPDS. In the control group three women out of 35 for whom data were available (8.6%), scored within the clinical range at 13 months (Table 1).

Of the PPD mothers 54% ($n = 15$) fulfilled criteria for one or more co-morbid personality disorder (PD). As reported previously (Smith-Nielsen et al., 2014), mothers in the non-clinical group also presented symptoms of PD, but none of them fulfilled diagnostic criteria for a PD diagnosis. Mothers in both groups primarily presented PD symptoms within Cluster C (i.e. Avoidant, Dependent, Obsessive-Compulsive, Passive-aggressive personality disorder). The

following PD diagnoses were represented in the PPD group: Paranoid (*n* = 2), Avoidant (*n* = 2), Obsessive-Compulsive (*n* = 1), Depressive (*n* = 3); Personality disorder not otherwise specified/mixed personality disorder (*n* = 13).

Infant developmental outcomes at 4 months

At four months we found developmental differences on the BSID-III between infants of PPD-mothers and the non-clinical group. MANOVA revealed a significant multivariate effect for group status (Wilks' Λ = .83, $F(5,70) = 2.83$; $p = .02$). As shown in Table 2, infants of PPD-mothers had lower scores on the cognitive scale than infants of non-clinical mothers at 4 months of age, adjusting for maternal education, maternal co-morbid PD and infant gender ($F(1,74) = 5.50$, $p = .02$, Cohen's $d = 0.8$). There were no significant effects of PPD on language or motor scales. No overall effects of infant gender, maternal education, or maternal PD were found, and the interaction term between PPD and child gender was not significant. Table 2 shows means and standard deviations for all five subscales in the PPD-group and in the non-clinical group at infant age of 4 months.

Table 2
Infant developmental outcome (BSID-III) at four months by group status

	PPD n=28		Controls n=53		
Outcome	Mean	SE	Mean	SE	p^a
Cognitive	9.18	.47	10.8	.38	.003
Language, receptive	9.94	.46	9.8	.37	.845
Language, expressive	9.34	.33	9.06	.27	.367
Fine motor	10.69	.54	11.29	.44	.319
Gross motor	11.27	.31	10.86	.26	.235

Note: Estimated means taken from models not including interaction terms. [a] Adjusted for maternal education, infant gender, and maternal co-morbid personality disorder.

Infant developmental outcomes at 13 months

At 13 months no differences in BSID-III scores between the PPD-group and infants of non-clinical mothers were found for infant cognitive, language, or motor development (Table 3). Sensitivity analysis including maternal concurrent depressive symptoms at 13 months in the model did not change the results. Therefore, to increase power, we only report findings unadjusted for concurrent

depressive symptoms at 13 months. Similar to the 4 months findings, there were no main effects of maternal PD or education, and also no moderating effect of infant gender.

However, independently of depression MANOVA revealed significant multivariate main effect for infant gender (Wilks' Λ = .83, $F(5,71) = 2.87$; $p = .02$). Boys scored significantly lower on the subscale 'receptive communication' (estimated $M = 7.74$, $SE = 0.64$) than girls (estimated $M = 10.04$, $SE = 0.66$; $F(1,75) = 10.92$; $p = .001$, Cohen's $d = 0.7$). Similarly, boys scored significantly lower (estimated $M = 9.49$, $SE = 0.32$) on the other language subscale, 'expressive communication' than girls (estimated $M = 10.36$, $SE = 0.34$, $F(1,75) = 5.96$; $p = .017$, Cohen's $d = 0.4$) (Table 3).

Table 3
Infant developmental outcome (BSID-III) at 13 months by group status

	PPD n=27		Control n=55		
Outcome	Mean	SE	Mean	SE	p^a
Cognitive	11.63	.52	11.81	.41	.760
Language, receptive	9.23	.65	8.79	.51	.551
Language, expressive	9.96	.34	9.48	.26	.205
Fine motor	10.34	.50	10.53	.39	.752
Gross motor	9.17	.54	9.07	.43	.866

Note: Estimated means taken from models not including interaction terms. [a]Adjusted for maternal education, infant gender, and maternal co-morbid personality disorder.

Discussion

In this study we examined effects of maternal postpartum depression (PPD) on infant development at 4 and 13 months in a well-resourced sample of first-time mothers meeting criteria for clinical depression and their healthy infants. To our knowledge, this is the first study to specifically examine early concurrent effects of exposure to maternal postpartum depression at the time when depressive symptoms are typically most present.

At 4 months of age infants of currently depressed mothers had lower scores on the cognitive scale of the BSID-III than infants of non-clinical mothers, the effect size being large. No effects were found for language or motor development. Since no previous studies have reported on early concurrent effects of PPD on infant cognitive development, it is not possible to directly compare our finding to those of others. However, previous research has documented concurrent

effects of PPD on other important indicators of early infant development. For example, infants of concurrently depressed mothers have been found to show lower activity levels, not only in interactions with the mother, but also when interacting with sensitive (but unfamiliar) others (Cohn, Campbell, Matias, & Hopkins, 1990; Field, 1995; Tronick & Reck, 2009). Furthermore, infants of currently depressed mothers have been reported to be less responsive to faces and voices (Field, Diego, & Hernandez-Reif, 2009) and showed distinct patterns of social withdrawal (Burtchen et al., 2013). Several items on the cognitive scale of the BSID-III require that the infant is interested in exploring and is responsive to the tester. Following, it may be argued that our finding might be a result of reduced responsiveness or social withdrawal in the infants of mothers suffering from PPD, resulting in a poorer performance on the cognitive scale of the BSID-III.

Despite these early differences in functioning between infants of depressed and non-depressed mothers, we did not find any developmental differences at 13 months. The results remained the same when we controlled for concurrent maternal depressive symptoms at 13 months. Also, no main effects of 13-month EPDS score or co-morbidity were detected. This indicates that there were no long-term effects of maternal depression diagnosed 3-4 months postpartum on infant cognitive, language, or motor development.

One conclusion that may be drawn from these findings is that maternal depression can have an acute concurrent effect on infant cognitive development, but that this effect is not necessarily persisting. Previous studies have also suggested that non-persistent PPD might not have long-term consequences for infant development. For example, Field (1995) found that infants of PPD-mothers who were no longer depressed by six months, no longer showed 'depressive behaviors' such as lowered responsiveness and lowered activity levels that they had shown while the mother was depressed. In another study, Field (1992) reported that infants of mothers who had recovered from depression by six months had normal scores on the BSID-I at one year. Similarly, Murray and colleagues found an adverse effect of PPD on Piaget's object permanence task at nine months but no overall effects were found on cognitive development at 18 months or at 5 years (Murray et al., 1996a; Murray, Hipwell, & Hooper, 1996b). In the present study, only six of the PPD mothers scored within the clinical range of the EPDS when screened 13 months postpartum, indicating that the majority of PPD mothers had recovered. Thus, early developmental delays may be caught up during the first year of life, if maternal depression resolves.

Our findings may also suggest that maternal postpartum depression *per se* might not be predictive of long-term infant development. In accordance with this, in a very large sample of 1329 dyads, Kurstjens and Wolke (2001) found that PPD alone did not affect cognitive development of

the child at 20 months, 5 years or 7 years. Adverse effects were only found in neonatal at-risk boys, when depression was chronic and occurred in combination with low SES status. Hence, other risk factors might play a more important role in predicting developmental outcomes as. In a recent large-scale study using the BSID-III, maternal occupation and educational level were important determinants of infant development (Koutra et al., 2012). Similarly, another recent study found that home environment, maternal occupation and education were significantly associated with scores on the BSID-III at 18 months, but not with maternal depressive symptoms in the postnatal period (Piteo, Yelland, & Makrides, 2012).

In the present sample of highly educated, well-resourced mothers, the lack of a long-term effect of PPD might be due to the absence of risk factors, such as social adversities often co-occurring with depression; however, it may also be due to protective factors in the infant's environment which may have worked as buffers. For example, only one mother in each group was single. A supportive partner may help the mother to cope better with her depressive symptoms (Misri, Kostaras, Fox, & Kostaras, 2000; Leahy-Warren, McCarthy, & Corcoran, 2012). Additionally, the partner-child relationship may have compensated for potential negative effects of maternal depression by providing a sensitive and stimulating caregiving environment for the infant. However, as we do not have data available in the present study that allows us to investigate this issue, the role of the partner/father as a potential buffering factor in the presence of maternal depression needs to be addressed in future research.

Another potential buffer in the present study might be fact that almost all mothers participated in a six-session cognitive behavioral based group intervention between four and seven months postpartum. Although psychological treatment of PPD not necessarily results in benefits in terms of infant outcomes, (Cooper, Murray, Wilson, & Romaniuk, 2003; Forman et al., 2007; Murray, Cooper, Wilson, & Romaniuk, 2003; O'Hara, Stuart, Gorman, & Wenzel, 2000), this might have facilitated earlier recovery and/or provided a feeling of social support, which in turn could have buffered negative effects of PPD on caregiving.

The absence of long-term effects on children's development in the current sample may also be partly due to the ample support that all new mothers in Denmark receive from the social security and healthcare system. This includes (at least) five routine home visits during the first year postpartum provided by a nurse specialized in perinatal and infant health, free access to health care services, and financial support during pregnancy leave.

Finally, when interpreting our results, it is worth drawing attention to the possibility that PPD may have had consequences for other aspects of infant development, such as social-emotional

development, even though we did not find long-term effects for cognitive, language and motor development. The BSID-III scales used in the current study do not measure infant behaviors during the test situation, for example irritability, social withdrawal, or infant positive/negative interaction with the tester. Neither does it capture other indicators of social-emotional development, such as infant attachment security or emotion-regulation capacities. Murray and colleagues did not find any main effects of PPD on child cognitive development at 18 months or at 5 years; still, adverse effects of PPD were evident for social-emotional development at 18 months, at 5 years, and in adolescence (Murray, Sinclair, Cooper, Ducournau, & Turner, 1999; Murray, Hipwell, & Hooper, 1996b; Halligan, Murray, Martins, & Cooper, 2007). In concurrence, it has been suggested that when evaluating parenting and effects on child developmental outcomes, there is a need to move beyond general notions of 'parental sensitivity' but instead to identify parenting behaviors specific for different domains of infant development (Bornstein & Tamis-Lemonda, 1997; Grusec & Davidov, 2010; Murray, 2014). For example, infant-mother attachment security is thought to be facilitated by sensitivity during distress (Leerkes, 2011) whereas cognitive and language development, is thought to be supported by parenting behaviors such as attention to infant activity and attention, scaffolding infant capacities, and book sharing (Grusec & Davidov, 2010; Murray, 2014) . Thus, maternal depression might affect some domains of parenting but not others; and therefore, we cannot rule out specific effects of maternal depression on the infant-mother relationship and/or infant social-emotional development beyond the period when mothers were suffering from depressive symptoms, which are not captured by the BSID-III at 13 months.

Gender and co-morbidity

We found no evidence in this study to support our hypothesis that boys of mothers suffering from PPD are at greater risk for developmental delay than girls of mothers suffering from PPD. At four months of age boys as well as girls of PPD-mothers scored significantly lower on the cognitive scale of the BSDI-III compared to boys and girls of non-depressed mothers. Similarly, we did not find a moderating effect of gender at 13 months of age. This is consistent with Cornish and colleagues who did not find any moderating effects of gender on infant development as measured by BSID-II (Cornish et al., 2005). Instead, regardless of depression group membership, at 13 months boys in our study scored significantly lower on language scale than girls, the effect size being large. This is in accordance with other studies showing that gender in itself may be a predictor of infant development. Two large scale studies of determinants of infant development found that

boys tended to score lower on the BSID-II (Wu et al., 2008) and BSID-III (Koutra et al., 2012) than girls. Further research is needed regarding normative language development in boys and girls.

Previous studies have found maternal co-morbid diagnosis or chronicity of depression to be important confounders or moderators of effects of depression on parenting and infant development (Conroy et al., 2010; Carter, Garrity-Rokous, Chazan-Cohen, Little, & Briggs-Gowan, 2001). In these studies negative effects on parenting were found only if the mother also had a co-morbid diagnosis. In the present study none of the mothers fulfilled diagnostic criteria for a second Axis-I diagnosis. As we did not include dimensional measures of other Axis-I psychopathology, we cannot exclude the possibility that subclinical levels of for example anxiety could play a role (see for example, Keim et al., 2011). However, we did use a well-validated measure of Axis-II psychopathology. More than half of the PPD mothers fulfilled diagnostic criteria for one or more co-morbid personality disorder (PD). Still, we did not find any associations between scores on the BSID-III and the combination of PPD and PD.

Limitations

A limitation of our study is the relatively modest sample size, restricting the possibilities for conducting sub-group analyses, for example to estimate effects of minor versus major depression. However, most of the women in our sample fulfilled criteria for major depression, and still findings were non-persistent. Therefore, it is not likely that we would have found associations between minor depression and BSID-III scores. As most of the PPD-mothers in our sample scored below the subclinical cut-off on the EPDS at 13 months, we cannot draw any conclusions regarding potential effects of more persistent depressive symptoms for children's development.

As mentioned above, another limitation of our study was that we could not take into account effects of subclinical Axis-I co-morbidity, such as symptoms of anxiety. Therefore, we cannot exclude that findings might have been different in a subgroup of mothers who suffer from PPD in combination with subclinical levels of anxiety. However, taking into account maternal co-morbid personality disorder, which is also often characterized by heightened levels of anxiety and stress, did not change our results.

Some previous studies only found effects of prenatal psychological distress, including depression during pregnancy for child development, indicating biological effects (for a review, see Kingston, Tough, & Whitfield, 2012). As we had no available data regarding antenatal depression and more global antenatal psychological distress, we cannot draw any conclusions regarding

potential biological risk in the children of our sample, although major physiological and neurological health problems were ruled out by our inclusion criteria.

Finally, it should be mentioned that generalizability of our findings is limited to low-risk populations. However, at the same time, this sampling strategy provided the opportunity to examine effects of postnatal depression in the absence of other severe socio-economic risks that often co-occur with maternal depression in high risk samples, making it difficult to disentangle independent effects.

Conclusions

Despite these limitations, our results suggest that even in well-resourced low-risk samples clinical maternal depression in the postnatal period can have an acute effect on infant cognitive development as early as at 4 months of age. However, in absence of other risk factors this effect may not be enduring. From a developmental psychopathology perspective this study stresses the importance of understanding the complex nature of how risk factors may impact on infant development differently at different ages. Instead of pointing selectively to a single predictor of developmental outcome such as PPD, cumulative risk theories have proposed that rather a combination of several risk factors may predict children's long-term developmental problems (Greenberg et al., 1999; Rutter, 1999; Sameroff & Fiese, 1999). In line with such theories, future research should focus on the combined effects of varying co-existing risk factors. Similarly, more studies are needed regarding potential protective factors on different levels, including access to welfare services, support from the partner and family, as well as individual parental coping capacities and intellectual resources.

Conflict of interest statement

None declared

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Appendix IV: PhD Paper 3

Under review

Postpartum depression and infant-mother attachment at one year: The impact of co-morbid maternal personality disorder.

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Running head:
Postpartum depression, personality disorder, and infant-mother attachment

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Abstract

Background: Across studies maternal postpartum depression (PPD) has been associated with disturbances in early mother-infant interactions that are assumed to be determinants of infant-mother attachment. However, results regarding effects of PPD on infant-mother attachment have been divergent. This may be due to not taking into account the effects of persistent psychological difficulties, not specific for depression, such as personality disorder (PD). This study is the first to examine the influence of comorbid PD with PPD in relation to infant-mother attachment. **Methods:** Mothers were recruited into a longitudinal study either during pregnancy (comparison group) or eight weeks postpartum (clinical group). Infants of mothers with depressive symptoms only or in combination with a PD diagnosis were compared with infants of mothers with no psychopathology. Depression and PD were assessed using Edinburgh Postnatal Depression Scale and the clinical interviews Present State Examination and Structured Clinical Interview for DSM-IV Axis II. Infant-mother attachment was assessed when infants were 13 months using Strange Situation Procedure. **Results:** PPD was associated with attachment insecurity only if the mother also had a PD diagnosis. Infants of PPD mothers without co-morbid personality disorder did not differ from infants of mothers with no psychopathology. **Conclusions:** Co-existing PD may be highly important in understanding how PPD impact on parenting and infant developmental outcomes. When providing interventions with the aim of preventing attachment insecurity, our results suggest the need for not only focusing on the acute depressive symptoms, but also to assess persistent factors magnifying or buffering effects on parenting and treatment outcomes. **Keywords:** Maternal depression, co-morbidity, personality disorder, infant-mother attachment.

Introduction

In past decades, maternal postpartum depression (PPD) has been identified as an important risk factor for the emergent infant-mother relationship and subsequent social-emotional problems in children. Features of maternal behavior which are generally assumed to be important determinants of infant-mother attachment insecurity and disorganization (Madigan et al., 2006; Beebe et al., 2010; Van IJzendoorn, 1995) have consistently been found to be disrupted in depressed mothers; they often show low sensitivity (Feldman et al., 2009; Murray, FioriCowley, Hooper, & Cooper, 1996), intrusive or withdrawn behavior (Field, Hernandez-Reif, & Diego, 2006), and compromised reciprocity (Beebe et al., 2008) during interactions with their children.

However, findings regarding effects of PPD on infant-mother attachment at one year have been contradictory. Some studies have found associations between PPD and infant-mother attachment, independently of whether the mother still presented depressive symptoms when infant-mother attachment quality was measured (Murray et al., 1996; Righetti-Veltema, Bousquet, & Manzano, 2003). Contrary to these findings, two large scale studies in population-based samples found no association between PPD and attachment quality at one year (Tharner et al., 2012a) and at 36 months (Campbell et al., 2004). In the latter study, only children of women with late, intermittent, or chronic depressive symptoms who were also low in sensitivity had a heightened risk of insecure attachment. The most consistent associations between depression and infant-mother attachment have been found in populations where the depressive symptoms occurred in combination with other severe psycho-social risk factors such as poverty (Lyons-Ruth, Lyubchik, Wolfe, & Bronfman, 2002, for a review, see Belsky & Fearon, 2008). However, in these samples it is difficult to disentangle effects of depressive symptoms from other environmental risk factors (Goodman & Gotlib, 1999).

The lack of consensus among studies may be due to a tendency to assume that depressive symptoms impact maternal behavior in a uniform manner disrupting the emergent infant-mother relationship. In fact, several studies have suggested that PPD-mothers may be a very heterogeneous group. A large group of PPD-mothers presents concurrent persistent psychological difficulties such as personality disorder (PD) or insecure attachment representations; and consequently, a substantial number of PPD-mothers do not have such difficulties (Akman, Uguz, & Kaya, 2007; Apter, Devouche, Gratier, Valente, & Le Nestour, 2012; McMahon, Barnett, Kowalenko, & Tennant, 2006). Accordingly, it has been suggested that the critical, intrusive, and coercive behaviors displayed by some depressed mothers, may not be specific to depression, but instead a consequence of other psychiatric conditions, such as chronic interpersonal problems or high levels of stress or anxiety even in the absence of depressive symptoms (Lovejoy, Graczyk, O'Hare, & Neuman, 2000).

Given that within adult psychiatry it is generally accepted that depression and PD often co-occur (Vilaplana, McKenney, Riesco, Autonell, & Cervilla, 2010; Viinamaki et al., 2006), strikingly few studies have examined effects of PD on parenting and the infant-mother relationship. Indeed, a recent systematic review on links between any PD and parenting emphasized that studies examining associations between psychopathology and parenting behaviors have focused on Axis-I disorders and not taken into account the impact of the more persistent personality disorders (Laulik, Chou, Browne, & Allam, 2013). Nine out of the identified 11 studies suggested that PD among mothers elevates the risk for impaired parenting behaviors, e.g., insensitive, intrusive, poorly

attuned and disrupted parent-infant interactions. Hence, when studying effects of PPD on parenting and infant social-emotional development, it seems essential to also take into account PD.

Studies focusing on effects of PD on infant-mother attachment are limited to one study. In this study it was found that infants of mothers with borderline personality disorder (BPD) had a higher risk for attachment insecurity and disorganization at one year compared with children of mothers with depression or no psychopathology (Hobson, Patrick, Crandell, Garcia-Perez, & Lee, 2005). Considering the severe disturbances in close interpersonal relationships that characterize BPD, this may not seem surprising; still, it remains unknown whether the associations with infant-mother attachment hold for other PDs.

To our knowledge, only two previous studies examined the cumulative effect of PPD and co-morbid PD on parenting and infant outcomes; both originating from the same research group. Conroy and colleagues compared early parenting behaviors and infant development at 18 months of age in dyads with mothers either meeting criteria for depression two months postpartum, PD, both conditions, or neither condition (Conroy, Marks, Schacht, Davies, & Moran, 2010; Conroy et al., 2012). They found that sensitivity, engagement, and being aware of infant care practices two months postpartum were negatively affected in depressed mothers only when they also had PD. Likewise, infant behavior was only dysregulated at 18 months, if the mother both had PPD and PD. The current study is the first to specifically examine the cumulative effect of PPD and PD on infant-mother attachment.

The present study

The present study aimed at further clarifying the role of personality disorders in the association between postpartum depression and infant-mother attachment. We examined this in an otherwise low-risk sample, thereby limiting the impact of confounding variables. We hypothesized that infants of mothers with both PPD and PD would be at greater risk for attachment insecurity and disorganization than infants of mothers with depression only or infants of non-clinical mothers. Based on previous findings from PPD samples similar to the current one with few risk factors besides the depressive symptoms (Campbell et al., 2004; McMahon et al., 2006; Tharner et al., 2012a), we expected that infants of mothers only presenting depressive symptoms would not differ from infants of non-clinical mothers.

Method

Participants and procedures

Mothers with postpartum depressive symptoms (clinical group) were referred to the research unit by public health care nurses based on routine screenings for postpartum depressive symptoms during home-visits eight weeks postpartum. The non-clinical group was recruited during pregnancy via advertising on webpages and at local midwife clinics. Thirty-two clinical mothers and 64 non-clinical mothers met the selection criteria for the present study, i.e. primiparous, no substance abuse, infant born at term, and mother and infant somatically well. Non-clinical mothers were eligible if they did not present symptoms of Axis I psychopathology at enrollment as assessed in a clinical interview.

Eight non-clinical mothers were excluded from the present study due to premature birth (n=1), development of major neurological illness of the child after birth (n=1), incomplete data (n=4), and drop-out during the project period (n=2), resulting in a comparison group of 56 women for the present study. Three clinical mothers dropped out after baseline-assessments, resulting in a sample of 29 clinical mothers. Five non-clinical mothers scored above cut-off for depression six to eight weeks postpartum, and were therefore counted as clinical mothers in the current study.

All assessments were conducted at the research unit. Clinical mothers were offered a six-session group psychotherapeutic treatment between baseline-interviews and infant-mother attachment assessment at 13 months. Twenty-six mothers participated in group sessions. Approval for the project was gained from the local Institutional Ethical Review Board, and written informed consent was obtained from each participating mother after the introductory meeting. For further details regarding recruitment, selection criteria, and procedures, refer to (Smith-Nielsen et al., 2014).

Measures

Maternal depression

Postpartum depressive symptoms were assessed with the Danish version of the Edinburgh Postnatal Depression Scale (EPDS: Cox, Holden, & Sagovsky, 1987; Nielsen, Videbech, Hedegaard, Dalby, & Secher, 2000). The EPDS is a 10-item self-rated questionnaire that measures symptoms of depression in the postpartum period (range 0-30). Scores above 10 to 12 are considered to indicate

probable depression and further assessment is recommended (Murray & Carothers, 1990; Cox et al., 1987). A score equal to or above 10 was used as cut-off in the present study. Clinical diagnoses of depression was confirmed with the standardized psychiatric interview Present State Examination (PSE:Wing, Cooper, & Sartorius, 2012). PSE was also used in the non-clinical group to ensure that mothers did not present symptoms of psychopathology at enrollment.

Maternal personality pathology

Symptoms of personality pathology were assessed with the Structured Clinical interview for DSM-IV axis II disorders (SCID-II:Gibbon, Spitzer, & First, 1997), the gold standard for diagnosing PDs (e.g. Kongerslev, Moran, Bo, & Simonsen, 2012). SCID-II is a semi-structured diagnostic interview for assessing the 10 DSM-IV PDs as well as depressive personality disorder, passive-aggressive personality disorder, and personality disorder not otherwise specified (PDNOS). It is based on a personality questionnaire consisting of 119 items each representing potential indicators of PD. The interviewer inquires to identify false positives. Following Verheul, Bartak, & Widiger (2007) PDNOS was diagnosed when a mother did not fulfill diagnostic criteria for any PD, but met five or more criteria across the specific PDs, causing significant impairment in functioning, not better accounted for by an Axis-I disorder.

SCID-II can be used to make a PD-diagnosis dimensionally (by noting the number of PD criteria met) or categorically (PD present or absent). We used both approaches, thus noting frequencies of PDs as well as noting number of criteria met within each PD. All interviews were administered by psychologists trained in SCID-II and sound recorded. Twenty-eight randomly selected interviews were rated by a second psychologist trained in SCID-II with no previous knowledge of the mothers. For the presence of any PD inter-coder agreement was 95% (κ = .90). For symptoms of PD intra class correlation coefficient was .96.

Infant-mother attachment quality

Infant-mother attachment was assessed when infants were 13 months old with the Strange Situation Procedure (SSP: Ainsworth, Blehar, Waters, & Wall, 1978; Main & Solomon, 1990), a well-validated and widely used twenty-minute observational procedure permitting reliable classifications of the quality of the infant-caregiver attachment relationship. With the aim of evoking mild stress that triggers attachment behavior in the infant, dyads are observed during eight brief episodes. Mother and infant are introduced to an unfamiliar room, a stranger enters the room, and the mother leaves the room twice. The child's attachment behaviors are observed when the mother returns to the room, and scored on four interactive scales: proximity seeking, contact maintaining, avoidance

of the caregiver and resistance. A secure child shows a pattern of high proximity seeking and contact maintaining behavior, low avoidance and low resistance. Disorganized infants show inconsistent and confused behavior, e.g., severe distress and contact-seeking behavior, followed by avoidance, prolonged stilling, rapid unexplained emotional changes, disorientation or fear during reunions.

Besides coding of attachment behavior according to the established categorical coding-system, we used continuous measures for attachment security and disorganization, which might be better suited to detect small effects (Fraley & Spieker, 2003; Jansen, Weerth, & Riksen-Walraven, 2008; Roisman, Fraley, & Belsky, 2007) as was expected in our study due to the size and low-risk nature of our sample.

An attachment security score was calculated from the four interactive scales (van IJzendoorn & Kroonenberg, 1990; Richters, Waters, & Vaughn, 1988) with higher values indicating more attachment security (see also Luijk et al., 2011; Tharner et al., 2012b). Continuous scores for disorganization were derived directly from coding the conventional 9-point disorganization scale (Main & Solomon, 1990) with higher scores indicating more disorganized behavior. Attachment behavior was coded from DVD-recordings by a certified coder (third author) trained at University of Minnesota with no previous knowledge of the study and blind to group status. For inter-coder reliability a randomly selected subset of 20 SSPs were coded by a second coder, trained at University of Minnesota. Inter-coder agreement for ABCD classification was 80% ($\kappa = 0.73$).

Statistical analysis

Differences in background variables were tested using independent samples T-test, Chi-square and Fisher's Exact test where appropriate. To test the hypothesis that infants of mothers with both depression and PD would be at greater risk for attachment insecurity and disorganization compared to infants of mothers with depression only or infants of non-clinical mothers, two Analyses of Co-Variance (ANCOVA)s were performed for attachment security and disorganization. The independent variable was 'maternal co-morbidity status' with three categories, 'Non-clinical', 'Depression only' and 'Depression+PD'. To address the specific study hypothesis concerning the added effect of maternal PD on infant-mother attachment quality, we compared mean attachment security and disorganization scores in the three diagnostic groups with the non-clinical group as the reference category. To facilitate interpretation, attachment security score and disorganization score were *z*-standardized. Additionally, we compared symptom severity in the three diagnostic groups

Table 1

Maternal and infant characteristics

Variables	Non-clinical dyads (n=56)		PPD dyads (n= 29)		*p*
Maternal age (mean; sd)	30.43	4.09	30.6	4.0	.78
Maternal age, range	23-43		22-39		
Single mother (n; %)	2	3.6	1	3.4	.73
Maternal years of education, (n; %)					.62
9-12 (ISCED level 3)	5	8.9	3	10.3	
14 (ISCED level 4)	4	7.1	2	6.9	
15 (ISCED level 5 to 6)	20	35.7	14	48.3	
17 or more (ISCED level 6 to 8)	27	48.2	10	34.5	
Unemployed (n; %)	5	8.9	5	17.2	.30
Maternal nationality (n; %)					.69
Danish	52	92.9	26	89.7	
Other European countries	4	7.1	3	10.3	
EPDS (mean; SD)	4.78	3.51	15.8	4.2	.00
Above cut-off for depression on EPDS (n; %)	5	8.9	29	100	.00
Co-morbidity status, One or more PD (n; %)	0	-	16	55.2	.00
Symptoms within PD clusters (mean, SD)					
Cluster A	0.04	0.19	0.7	1.6	.035
Cluster B	0.07	0.32	0.8	1.5	.017
Cluster C	0.25	0.61	4.8	3.8	.000
Infant gender (n; %) Male	26	46.4	15	51.7	.66
Gestational age at birth, (weeks; SD)	40.6	1.22	40.1	1.6	.12
Gestational age at birth, range	38.1-42.4		35.3-42.1		
Infant birth weight, g. (mean; SD)	3594	522	3447	348	.21
Infant birth weight, range, g.	2620-4900		2730 – 4600		
Infant Attachment classification (n; %)					.51
A (Insecure-Avoidant)	7	12.5	1	3.4	
B (Secure)	37	66.1	19	65.5	
C (Insecure-resistant)	6	10.7	5	17.2	
D (Disorganized)	6	10.7	4	13.8	

Note: ISCED = International Standard Classification of Education by UNESCO; Cluster A = Paranoid, Schizoid, and Schizoid PD; Cluster B = Antisocial, Borderline, Histrionic, and Narcissistic PD; Cluster C = Avoidant, Dependent, Obsessive-Compulsive, Depressive, and Passive-aggressive PD.

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using ANOVA to be able to detect if mothers with a PD diagnosis also differed from the 'Depression only'-group in severity of depression.

We used maternal education, unemployment status, and infant gender as covariates in the main analyses, due to their potential confounding effects on infant social-emotional outcomes (Belsky & Fearon, 2008; Goodman & Gotlib, 1999; Weinberg, Olson, Beeghly, & Tronick, 2006). Additionally, we included maternal country of origin in the analysis with attachment security as an outcome and maternal age in the analysis with attachment disorganization as an outcome, because including these variables changed the effect estimate by > 5%.

Analyses were performed with and without the five non-clinical mothers who scored above cut-off on the EPDS. As this did not essentially change the results, we included them in the PPD group to increase power.

Results

Sample characteristics

The clinical group did not differ from the non-clinical mothers in terms of basic demographic characteristics (Table 1). Confirming the low-risk nature of the sample, maternal employment and level of education was high, with the majority of mothers having completed an education on the level of a Bachelor's degree or more. Only two mothers were single, and infants were born with normal birth weights. As shown previously (Smith-Nielsen et al., 2014), the two groups differed with respect to maternal PD. Mothers in both groups presented symptoms of PD, primarily within DSM-IV Cluster C. However, only mothers in the clinical group fulfilled diagnostic criteria for PD.

Table 2: Infant attachment security and disorganization by maternal diagnostic status

		Attachment security, z-score[a]				Attachment disorganization, z-score[b]			
	n		*F* (df)	*p*	R^2		*F* (df)	*p*	R^2
Maternal diagnostic status	85		3.77 (2)	.027	.104		0.78	.463	.074
		Mean (SE)	*B* (SE)	*p*		Mean (SE)	*B* (SE)	*p*	
Non-clinical	52	-0.09 (0.23)	Ref	-		-0.35 (0.24)	Ref	-	
Depressed only	17	0.26 (0.27)	0.35 (0.29)	.231		0.01 (0.28)	0.34 (0.29)	.257	
Depressed + PD	16	-0.69 (0.32)	-0.60 (0.28)	.037		-0.19 (0.33)	0.16 (0.29)	.581	

Note: Results of Analyses of Co-Variance with planned contrasts. Means are estimated marginal means. [a] adjusted for infant gender, maternal unemployment status, and level of education. [b] adjusted for infant gender, maternal unemployment status, and age, level of education. PD = one or more personality disorder. Ref = Reference group.

Maternal diagnostic status and infant attachment

The majority of infants was securely attached, i.e. 65.6 % of the clinical dyads and 66.1 % of the non-clinical dyads. When comparing infants of clinical-mothers with infants of non-clinical mothers, no differences were found with respect to the conventional ABCD-classifications (Table 1).

However, as shown in Table 2, when using continues outcome measures we found differences in attachment security scores between the three diagnostic groups (F[2]= 3,77, p = .027, R^2 = .104). When comparing mean attachment security scores, we found that only infants of mothers with both depression and PD differed from the two other groups. Infants of mothers with both depression and PD had significantly lower security scores (Mean *z*-score = -0.69, SE = 0.32) than infants of non-clinical mothers (Mean *z*-score = -0.09, SE = 0.23, p =.037) and infants of mothers with depression only (Mean *z*-score = 0.26, SE = 0.27, p = .009). Infants of mothers with depression only did not differ from infants of non-clinical mothers in attachment security. With respect to infant disorganization scores, no significant differences were found among infants of mothers with both depression and PD, infants of mothers with depression only and infants of non-clinical mothers.

Table 3: Severity of depressive symptoms by maternal depression group and PD status.

		EPDS			
	n		*F* (df)	*p*	R^2
Maternal diagnostic status	85		111.86 (2)	.000	.732
		Mean (SE)	*B* (SE)	*p*	
Non-clinical	52	4.19 (0.47)	-12.06 (0.97)	.000	
Depression only	17	14.65 (0.82)	-1.60 (1.18)	.178	
Depression+PD	16	16.25 (0.85)	Ref	-	

Note: results of Analyses of Variance. Means are estimated marginal means.

PD = one or more personality disorders. Ref = reference group

To test whether the findings regarding attachment security could be explained by higher depression scores in the group of mothers with comorbid PD, we conducted additional ANOVAs (Table 3). We found similar levels of depressive symptoms in mothers with depression only (M = 14.65, SD = 0.82) and mothers with comorbid PD (M = 16.25, SD = .178). This suggests that the presence of PD, and not differences in depressive symptoms, accounted for the higher rates of infant attachment insecurity in this group.

Discussion

This study was the first to examine the role of co-morbid personality disorder when examining an association between maternal postpartum depression and infant-mother attachment. We found that in an otherwise low-risk sample, depression was associated with attachment insecurity only if the mother also had a PD diagnosis.

Previous studies regarding effects of PPD on infant-mother attachment quality have been contradictory. This might be due to the heterogeneity of the group of mothers with postpartum depression. Considering that it is well established that depression often co-occurs with PD (Corruble, Ginestet, & Guelfi, 1996), it is striking how understudied this aspect is within the field of infant mental health. Our findings stress the importance of not only focusing on the acute maternal depressive symptoms when studying effects of PPD on infant outcomes; but also to take into account more persistent maternal psychological difficulties, such as PD. As pointed out by Lovejoy and colleagues (2000) symptoms of depression do not *per se* predict the behavioral expressions often associated with depression during observation of mother-infant interaction, e.g., hostile, intrusive, or withdrawn behavior.

It has been suggested that maternal PD can interact with depressive symptoms in affecting parenting behavior and child developmental outcomes (Conroy et al., 2010; Conroy et al., 2012). This concurs with our finding that although levels of depression were similar in both clinical groups, higher attachment insecurity was only found in the group of mothers with both depression and PD. Although based on the current data, we cannot rule out that this finding was explained by personality dysfunctions only, previous studies indicated that the combination of PPD and PD might be particularly worrisome (Conroy studies). Conroy et al. showed parenting behavior two months postpartum and infant dysregulated behavior at 18 months were only negatively affected, if mothers had both PPD and PD, suggesting it was the cumulative effect of PPD and PD and not an effect of PPD or PD only that accounted for the adverse effects.

Having persistent relationship-oriented difficulties, which is the essence of PD, may play a key role in explaining why some depressed mothers are able to provide sensitive and appropriate caregiving, while some depressed mothers are not. It has been proposed that the capacity for mentalization plays a crucial role in the severe difficulties in affect regulation and interpersonal functioning associated with PD, not only in close relationships in general, but also in mother-infant interaction (Bateman & Fonagy, 2004; Grienenberger, Kelly, & Slade, 2005; Lysaker, Gumley, & Dimaggio, 2011). Mentalization enables the mother to recognize and regulate the infant's affective states as well as to regulate her own emotional distress (Fonagy, Gergely, & Jurist, 2002). Accordingly, studies have found mentalization skills in parents to be an important predictor of infant-mother attachment ((Fonagy, Steele, Steele, Moran, & Higgitt, 1991; Slade, Grienenberger, Bernbach, Levy, & Locker, 2005), as well as a mediator between the quality of mother-infant affective communication and infant-mother attachment quality (Grienenberger et al., 2005). A mother struggling with both depression and PD may be less able to regulate her own affective states as well as her infant's affective states because of impaired mentalization. This may account for our finding that PPD was only associated with infant-mother attachment insecurity if the mother also had PD. More research is needed to evaluate if mentalization can explain negative effects of co-morbid personality disorder on child socio-emotional outcomes.

As expected, infants of mothers only presenting symptoms of depression but no PD did not differ from infants of non-clinical mothers with respect to attachment quality. This is concurs with previous findings from low-risk samples that PPD alone may not be associated with infant-mother attachment insecurity (Tharner et al., 2012a; Campbell et al., 2004; McMahon et al., 2006). Mothers with depression only, might be better able to cope with their symptoms than mothers who additionally face more persistent difficulties in affect regulation and interpersonal relationships. Furthermore, depressed mothers without PD might be better able to use their resources and profit from protective factors such as social support or the psychotherapeutic interventions offered to depressed mothers in the current study in comparison with mothers with co-morbid PD. For example, meta-analytic evidence shows that co-morbid PD doubles the risk of poor treatment outcome for depression (Newton-Howes, Tyrer, & Johnson, 2006).

Contrary to our hypotheses, we did not find an elevated risk for disorganized attachment representations in infants of mothers with both depression and PD. This might be explained by the low-risk nature of our sample. Associations between maternal depression and attachment disorganization are most likely found in high-risk samples with multiple risk factors (van IJzendoorn, Schuengel, & Bakermans-Kranenburg, 1999). In our sample, consisting of well-

resourced women, it is possible that protective factors, such as a supportive partner, high levels of education, and access to the extensive Danish healthcare system, buffered the effects of maternal psychopathology on attachment disorganization, even in the context of both depression and PD. Taken together these findings support models of cumulative risk in the explanation of outcomes for children of depressed mothers (Goodman & Gotlib, 1999).

The study has a number of strengths. First, using a longitudinal design allowed us to examine temporal associations between maternal diagnostic status two to three months postpartum and infant attachment status at one year. Second, we used golden standard measures of maternal PD status as well as infant-mother attachment relationship, hereby ensuring high validity and reliability of the studied constructs. Third, beside depressive and PD symptoms, our sample was highly homogeneous with respect to basic demographic variables, thereby minimizing the effects of confounding variables. However, certain limitations need to be acknowledged when interpreting our findings: The moderate size of our sample did not allow us to perform subgroup analyses with respect to PD clusters or specific PDs or to examine differences in categorical infant-mother attachment classifications. Furthermore, the fact that no mothers in the comparison group fulfilled criteria for PD prevented us from analyzing data with respect to effects of PD only. Therefore, it is not possible to disentangle effects of PPD and PD. These issues need to be addressed in future research.

Conclusion

Despite these limitations, this study stresses the need for taking into account psychological factors that may buffer or magnify adverse effects when studying effects of PPD on infant developmental outcomes. PPD-mothers may be a very heterogeneous group, and potential co-existing PD may be highly important in understanding how PPD impact on parenting and infant developmental outcomes. Considering that patients with co-morbid PD and unipolar depression have been showed to have a heightened risk for poor treatment outcome in comparison with patients with no co-morbid PD (Newton-Howes et al., 2006), this seems crucial when providing interventions with the aim of preventing poor infant social-emotional outcome. Future research will bring us closer to a full understanding of the effects of combined risk (and protective) factors influencing attachment security and disorganization.

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